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ABSTRACT

A study examined the degree of reindustrialization underway and planned for in the greater Toledo area located in northwestern Ohio. It also analyzed the perception of manpower requirements needed to support such a reindustrialization effort. During the study, researchers reviewed literature dealing with current employment patterns and labor needs around the country and in the Toledo area in particular. Also, they examined literature devoted to the prospects for computer-integrated manufacturing. In addition, they surveyed 27 representatives (predominantly executives and administrators) of 27 Toledo-based firms in order to determine the firms' current and planned use of high technology. Based on data obtained from the literature review and from the survey, the designers of the study made the following conclusions and recommendations: (1) economic development in the Toledo area must concentrate on high technology application rather than on development of high technology industry; (2) a survey of high technology activity in the non-manufacturing sectors of the Toledo economy must be undertaken; (3) local industry should be sensitized to the benefits and applications of high technology; (4) strategic planning for skilled manpower must be developed and implemented; and (5) a coordinating center for high technology activities should be developed in the Toledo area. (The survey is appended.) (MN)

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# HIGH TECHNOLOGY IN THE MANUFACTURING SECTOR OF THE TOLEDO ECONOMY

A REPORT TO

PRIVATE INDUSTRY COUNCIL
TOLEDO, OHIO

BY

IVAN G. KURTZ, PH.D.

U.S. DEPARTMENT OF EDUCATION
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# PREFACE

American society has met many challenges and crises in its relatively short history. Wars, economic collapse, nativism, and race relations are only a few of the major disruptions this country has had to face. Economic and social changes on a world-wide scale, that have been germinating since World War II, have brought renewed and pervasive threats to the American "way of life." These changes stem, in part, from the blossoming of the developing nations as marketing competitors for this industrialized nation. A major role-maker in these changes, however, stems from the sharpened pace of goods production and altered lifestyle as a result of a sophistication in what is loosely defined as "high technology."

This study grew out of the experiences of a local college, Owens Technical College, to respond to the critical problems facing its community to reindustrialize an aging and increasingly inefficient manufacturing base. A proposal was prepared to fund a basic survey effort in order to gain a broad picture of the degree of reindustrialization underway and/or planned as well as to determine the perception of manpower requirements needed to support the reindustrialization effort. This proposal was presented to the local Private Industry Council (PIC) for Employment Generating Services funding.

The balance of this document is a report of the activities resulting from the funds approved by PIC. There are many who deserve a note of thanks for their assistance, interest, and time devoted to making this project successful. First, the 27 "panelists" who responded to the survey should be noted. Without their input, the final recommendations could hardly have been formulated. Second, the High Tech Task Force became an invaluable and indispensible resource for the director of the project. The experience of

being recruited for volunteered services in this project ran true to form with many other volunteer efforts in that many unexpected meetings and hours of deliberation were required. Fortunately, this group gave generously of their time. Their respective firms are to be commended for providing release time to attend meetings. The members of this task force were:

| | |
|---|---|
| Stan DeGroff | American Motors - Jeep |
| Earl Dietz | Owens-Illinois, Inc. |
| William Free | University of Toledo |
| Ron Hintz | Teledyne CAE |
| David Hufford | Ohio Technology Transfer Organization |
| Robert Schaefer | Owens-Corning Fiberglas |
| Tom Scherer | Chamber of Commerce |
| Ed Schulte | Chamber of Commerce |
| Howard Selland | Libbey-Owens-Ford Co. |
| William White | DeVilbiss Company |

The author also wishes to express appreciation for the support and interest in this project by numerous leaders in the community; including, Mr. Steve Stranahan, Entelco; Mr. Joe Tomasi, UAW Local 12 Region 2B Director; Mr. Tony Swoope, Bureau of Apprentice Training; and Mr. Jim Beshalske and his staff at the CETA Consortium. A special thanks is made to Mr. J. Michael Porter, President of the Chamber of Commerce, and Mr. Jack Hoyt, Champion Spark Plug and Chairman of the Private Industry Council, for their co-authored, introductory letter for the survey which was sent to the Chief Executive Officers of those firms identified to be contacted for this project. The consultant services by Mr. Kay Hardesty of Technical Assistance Associates (TAA) were invaluable on key issues. The consultative services provided by Arthur D. Little, Inc., through Libbey-Owens-Ford Company and the computer services provided by Owens-Corning Fiberglas improved the overall quality of this survey.

The encouragement of Dr. Jacob H. See, President of Owens Technical College, was an important factor in the staying power to complete the project. Other staff members of Owens College also provided invaluable assistance. In particular, I would mention Dr. Michael Roetter for his research assistance, and my secretary, Ms. Pam Pullella, whose untiring attention to details and creative skills and suggestions made this report immeasureably better than it otherwise would have been.

# CHAPTER 1

# INTRODUCTION

## Statement of the Problem

This paper addresses the context of high technology in the manufacturing sector of the Greater Toledo Area. An assessment is needed to determine the extent of the implementation of high technology in our factories both in the present time and that which is anticipated to be implemented in the next few years. An important key to enable our present industry to successfully implement high tech equipment is to have sufficient services and resources available in the community to support both the current and projected levels of high technology equipment demands. Competing effectively with other communities across the nation for new and expanding industries cannot be accomplished with a haphazard appeal that lacks a fundamental understanding of our high technology capability now and in the future. This study examines that context from several angles with the intent that its conclusions and recommendations will provide dependable data and input on which planning decisions can be made by firms individually and in concert with one another and by community planning councils to prepare for a more vibrant community tomorrow.

## Goals and Purpose of the Study

The goals of this study are to accomplish the following:

1. Develop a review of the literature and analysis of available data to determine the trend and relative strength of the manufacturing sector of the Toledo metropolitan area.

2. Conduct a survey of experts in the manufacturing sector in plants in Northwest Ohio that:
   a. Identifies the implementation of automated manufacturing equipment:
      (1) As presently in use; and
      (2) As an average annual percentage increase projected through 1987.
   b. Identifies the difficulty in recruiting manpower by skill level required for automated manufacturing equipment:
      (1) Presently in use; and
      (2) Projected to be implemented through 1987.
3. Make a minimum of five recommendations to the Private Industry Council for implementation that will enhance the growth and development of firms that employ automated manufacturing equipment in their manufacturing process.

Delimitations

This study is governed by three delimitations for the purpose of providing a focus and manageable range of concerns. The first is the exclusion of all forms of production except the manufacture of durable goods in the six Standard Industrial Classification (SIC) codes of Glass (32), Primary Metal (33), Fabricating (34), Machining (35), Electrical Equipment (36), and Transportation (37), all of which are significant for the Toledo area economy.

The second delimitation defines the geographical parameters of the firms reviewed. The phrase used in the study is "Toledo Metropolitan Area" and consists of firms located in Lucas (including the city of Toledo), Wood, and Ottawa Counties. The identification of the total population of firms was defined as firms listed in the Harris Ohio Marketers Industrial Directory, 1982.

A third delimitation is a definition of the term "high technology." This terminology has recently become popularized and applied to a wide range of ill-defined applications of newly designed equipment. As suggested in a national study conducted by a Joint Committee of Congress, the term "high technology" is defined differently by almost everyone using the term. For the purpose of this study the term refers to the use of computer-based equipment that is employed in manufacturing processes and is identified variously as "automated manufacturing," "computer-assisted engineering" (CAE), and "computer-integrated manufacturing" (CIM).

# CHAPTER 2

## A REVIEW OF LITERATURE ON THE MANUFACTURING SECTOR

The structure of this chapter was a review of relevant, published material and personal interviews with experts that were related to an analysis of the economic status of the manufacturing sector of the economy. The perspective considered was the potential for high technology in the manufacturing sector and the anticipated impact that potential poses for the manufacturing sector on both the national and Toledo area scene.

### THE NATIONAL SCENE

This study first considered the fundamental trends in the manufacturing sector as viewed from a national perspective. Issues of world-wide competition and the development and growth of automation and manpower issues, such as joblessness and skill requirements, were reviewed.

#### Decline in the Workforce Requirements

The prospects for the manufacturing sector of the U.S. economy in both the immediate and long-term future appear dismal to even a casual observer. This nation's economy has moved with incredible speed from a base of mass production of goods that employed a majority of American workers as late as World War II to only 13 percent of the total workforce by 1982. Furthermore, only half of this 13 percent today are involved in the manufacture of mass-produced goods which traditionally has been the mainstay of the American economy and world leadership. The other half of the manufacturing workforce, or 6.5 percent, is employed in specialized and small-batch production, such as aircraft, computer mainframes, communications satellites, and space exploration hardware.

One illustration of many that could be cited to demonstrate this reduction in mass-production employees is the Chrysler Corporation which reports that its workforce lost 6,000 skilled, mid-career employees during the 1970s. An estimate has been made by one expert, David Snyder, that at the present time 20,000 blue-collar jobs are eliminated monthly as a result of expanding imports into the U.S. of manufactured goods and raw materials. (52:18-19)

One of the principal forces leading to this demise of the production levels, according to Jerry Flint who wrote in Forbes, is "the auto industry's trouble, of course, [that has] caused most of the pain." (21:19) He quotes Rene McPherson of Stanford University and former chief executive of the Dana Corporation who suggests that the pressure American production currently faces is tantamount to a Pearl Harbor, and "it's much worse than most people think." (21:18)

In his article, "Trouble in the Heartland," Flint estimates that currently some 200,000 workers are on indefinite layoff from the auto companies and an equal number from the auto suppliers. Flint further suggests that even if there is a recovery in the auto, steel and metal-working industries, that one-fourth of the jobs of those currently unfilled may have disappeared. (21:20) Flint's prognosis is confirmed by a recent federal government study which projects a loss of 500,000 auto manufacturing jobs in the 1980s. He notes that this reduction comes on the heels of a loss of 361,000 jobs in all manufacturing jobs in the 1970s. (21:21-22)

Heavy concentration of the auto industry in the so-called "heartland"--the five Great Lakes states of Ohio, Indiana, Michigan, Illinois, and Wisconsin plus western Pennsylvania, New York and the

eastern reaches of Missouri--has had a particularly negative impact on this region as compared to other sections of the nation. The 1980s will no doubt be a watershed for the heartland in the sense that its economic base will either begin to be rebuilt or it faces a pending crisis of a disinvestment that will rob the life chances of its youth, its capacity for local self-rule, and much of the useful wealth created by several generations. (35:5)

Shifts in the Economic Base

Fortunately, such a challenge of rebuilding an economic base is not without recent precedent, as demonstrated by the state of Massachusetts. Faced with the demise of much of its industry after World War II, such as the textiles' move to the Sunbelt, Massachusetts often led the nation in unemployment statistics from the mid-1950s through the 60s. Each cyclical economic downturn seemed to leave the state in a more precarious circumstance. However, a shift began subsequent to the 1950s to the high technology electronics industry which settled near Boston on Highway 128. This new industry came to exercise a major impact in rebuilding portions of the state's economy in the 1970s so that its unemployment rate in the current recession is one of the lowest of all the industrialized states.

David L. Birch, an economist at MIT, suggests there is a basic restructuring of the U.S. economic base underway as it moves from a manufacturing to a non-manufacturing economy. He notes that we have witnessed a decline of the blue-collar and agricultural labor force from one-half to one-third of the labor market from 1950 to 1980. Today, fully one-half of the total work force is white-collar workers in professional/technical roles. (7:8) In 1981, the number one occupation in the U.S.

was a clerk; or, as Naisbitt describes the change, fully 55 percent of all employees are "information workers," i.e., they are paid to process data or information. (34:2) This shift from manufacturing to non-manufacturing, Birch notes, is moving at a pace of approximately one percent per year since 1974. Hence, out of the total blue-collar labor force today, only 13 percent are represented by the manufacturing production worker. (7:10) By adding to this worker classification the construction, agriculture and mining industries, the total of all blue-collar workers account for the one-third portion of the labor market noted above.

Reference is often made to the shift from manufacturing to services, but this is probably an inadequate description and serves as only a nominal indication of the true picture. Rather, as Birch suggests, the shift involves a move from "things that require muscles and dexterity into things that require thinking," or as he terms it, a shift from "hardware to thoughtware." (7:2) He suggests that the move is toward becoming "in essence the creativity center of the world" (7:4) and that potentially the manual lathes on the shop floor in the antiquated factories are destined for the Smithsonian Institute. A similar point is made by John Naisbitt, one of today's most popular trend forecasters, who traces the movement of American society first from agriculture, then to industrial, and now to what he terms an "informational" society. (34:2)

An analysis of the Nobel awards gives some weight to Naisbitt and Birch's assertion of this nation's creative possibilities that germinate from its citizen's traits of entrepreneurship, inventiveness and individualism. The U.S. has had recipients of 92 awards as compared to only 53 awarded to Europeans and 2 to Japanese. The latter, which has become a

major competitor for the U.S. and not an inconsiderable threat, is seen by Birch more as a challenge of excellent immitators rather than innovators.

Birch's evaluation of the nature of the Japanese threat to American industry is supported in an article, "Why Japanese Factories Work," by Robert H. Hayes and published in the Harvard Business Review. He suggests that the Japanese achieved their current level of manufacturing excellence mostly by doing simple things, yet doing them very well and slowly, improving upon them all the time. (26:57) A similar report was recently made by Peter Blake of the Society of Manufacturing Engineers, (SME) who accompanied a delegation from the SME to study the Japanese industry. (32)

Other shifts that are underway on the American scene which complement the move from "hardware" to "thoughtware" include the shift from larger to smaller scale enterprises and from physical capital to human capital. Most significant, of course, is the shift from an independent to an interdependent economy with the rest of the world. (7:2-3) Since 1955 the import/export traffic of the U.S. doubled. Although the nation is becoming a net importer of manufactured goods, it is at the same time becoming a net exporter of services--an export level that represents 20 percent of the world's service base. While the U.S. imported $35 billion in manufactured goods last year, it exported an equal amount in services.

During the period 1955-1980, in which the import/export trade doubled, one study of the New England region shows there were 660,000 manufacturing jobs lost while 1.1 million jobs in services and high technology were created. The impact of the new economic base of the state of Massachusetts, one of the states in the region studied, can be seen in

comparing its unemployment rate. In the 1974-75 recession, Massachusetts' unemployment was 12 percent while in the current 1982 recession it is the second lowest in the nation. (7:3) Similarly, a shift from manufacturing to service-oriented jobs occurred in the Upper Great Lake states in the 1978-81 period when 138,000 manufacturing jobs were lost but 307,000 service jobs were gained. The state of Michigan, one of the Upper Great Lake states, lost 90,000 manufacturing jobs but gained 456,000 service jobs in the decade of 1972 to 1982. (7:5) The Occupational Outlook Handbook predicts that from 1978 to 1990 the service-producing industries are expected to increase from 60.4 million to 78.4 million, or a 30 percent increase. This compares to an increase in the goods-producing industries from 28.7 to 32.5 million workers, or only about 13 percent. Of this 13 percent increase in goods-producing workers, there will be a 19 percent increase in durable goods production workers. Within this latter category, the craftworkers will increase 20 percent (12.4 to 14.9 million), while operatives will see a 15 percent increase from 10.9 to 12.5 million. (41:20)

A final shift to note is the North-to-South movement of the population. In 1980, for the first time in this country's history, more people lived south of a line drawn across the middle latitude of the U.S. than lived north of it. (53:2)

Potential Displacement of Workers

Given the current threat from the realignment of manufacturing production in the world's economy and standing on the threshold of the factory of the future's Computer-Integrated Manufacturing (CIM) era, many U.S. manufacturing firms envision their future viability to be in the implementation of automated manufacturing production processes. Labor-saving devices are increasingly being viewed as a panacea of improved

productivity that can make American-produced goods compete effectively in the world market. This panacea, however, is a double-edged sword because, as more and more goods can be created with fewer workers, the result is an unacceptably high unemployment rate.

In a study conducted by the Robotics Institute of America, firms were surveyed to ascertain the percentage of jobs that could be eliminated by non-sensor-based robots available on the market today (identified as Level 1 robots) and by the next generation of robots with rudimentary sensing capabilities (Level 2 robots). Results of the survey show that, theoretically, one million operators could be replaced by Level 1 robots and three million by Level 2. This displacement is projected by the study to take place over a 20-year period. In the year 2025, however, the study concluded that "it is conceivable that more sophisticated robots will replace all operators in manufacturing . . ., as well as a number of routine nonmanufacturing jobs." (5:42)

The corporate consulting firm of Arthur D. Little, Inc., expects that over half of all unskilled and semiskilled workers in manufacturing that could be replaced by robots are concentrated in the metalworking sectors, and that half of these displaced workers are geographically centered in the five Great Lakes States (Indiana, Illinois, Michigan, Ohio, and Wisconsin), New York, and California. The long-range future for employment in the manufacturing sector is complicated by the fact that in 1980 between two-thirds and three-fourths of all potentially displaced workers are less than 45 years old and only one-third of them would be of normal retirement age by the year 2000. (5:43) It is not expected, therefore, that large-scale retirements will diminish the "structural unemployment;" i.e., persistent unemployment that is caused by technical change, by

shift in composition of demand, and by competition of imports with domestic production. (42:16)

Issues in Reindustrialization

The Herculean task of providing a purposeful life to such vast masses of potentially unemployable workers is not, however, without historical precedence. At the end of World War II, for instance, there was a critical need to reorient the production facilities all across the country that had helped supply the 1941-45 war effort. The problem was particularly acute in the Detroit area. Preserving and revitalizing Detroit's aging industrial base in the post-war era through a planned conversion to the production of socially useful goods needed by America and the world was crucial. The proposal to convert to the production of building supplies for low-income housing was popularized by Walter Reuther of the United Auto Workers. (35:11) The subsequent success of this proposal was no doubt greatly aided by the impetus of the government-backed mortgage guarantee programs of the Federal Housing Authority and the GI Bill which came into existence after World War II.

The year 1982 found Detroit with some of the same demands of reorienting an aging industrial base as existed 40 years ago and, once again, the UAW has undertaken a leadership role in searching for a program through a study by Dan Luria and Jack Russell. They concluded from their review of the present state of affairs that a fundamental question must be accommodated in order for there to be a revitalization of the Detroit region. That question is:

> "What products can re-employ a large number of skilled or semi-skilled workers, at or near their accustomed wage, taking maximum advantage of the area's concentration of metal-working capital stock and labor force training and of the . . . deep waterway location, producing products for a growing, under-

> supplied, long-lived national and international market for which the business cycle is either absent or opposite to the auto/auto parts demand cycle?" (35:12ff)

A basic assumption of the Luria and Russell position is that potential new industries do exist that have a similar wage scale, standard of living, and transfer of skills associated with them that are comparable to the auto industry. Nevertheless, these authors are reluctant to embrace a "services economy" as a viable alternative due to what they percieve to be lower wage scales and different skills required. Similarly, Representative John Seiberling (D-Ohio) of Akron is quoted that he likens "service jobs to taking in other people's washing. They don't add that much to the economic base. Retail jobs pay one-third the rubber or steelworker rates . . . It's absolutely a lower standard of living, not really a substitute." (21:20)

Luria and Russell propose nine criteria to be used in selecting potential economic redevelopment ventures:

1. Will the ventures provide substantial employment?
2. Can the venture firm reuse significant portions of existing industrial facilities and equipment?
3. Will new ventures provide an export role in the local economy?
4. Are demands for products of new ventures strong enough to justify capital investment?
5. Will present labor and linkages of the metal industry be utilized by the new ventures?
6. Is demand for new venture products stable and/or counteract auto cyclical trends?
7. Do new ventures propose comparable wage scales to auto workers?

8. Do transportation costs of moving product to market destinations assure a price advantage?
9. Do proposed new ventures provide above average profitability and a growing economic sector that can accommodate new entrants? (35:15)

High Technology--A Panacea?

One of the popularized answers to questions such as these by communities across the country who are facing some of the same issues growing out of a declining industrial base as Detroit's is "high technology." This approach is well illustrated in the statement of Dick Molpus, an aide to the governor of Mississippi. He says, "Mississippi, like the Heartland, wants high-tech jobs. We're not going to turn Mississippi into Silicon Valley over the next five years, but we're moving away from the low-wage, highly labor-intensive factors of the past 20 years toward higher-paying, high-technology jobs." (21:23) A study by the Subcommittee on Monetary and Fiscal Policy of the Joint Economic Committee of the Congress, published in June, 1982, found numerous attempts across the country "to remove information barriers that impede technology transfer. High technology councils, public or private, have been formed in many states to disseminate information about scientific advances, educate the public on the importance of technological progress, and influence state education policy toward the sciences." (51:39)

A cautionary note is sounded in an editorial in the Wall Street Journal, by Aaron S. Gurwitz who reviews these high tech developmental efforts as the "latest . . . fad to hit the streets of America." (24) He recalls several preceeding, regional-revival fads. In the 60s the fad was to save the urban centers via the pedestrian mall, in the 70s came the "service-sector strategy," and now, in the 80s, as he sees it, is high

technology. He expresses concern that too many scarce public and civic resources will be wasted if the high tech fad is allowed to go through the same full-life cycle as downtown pedestrian malls or the service-sector strategy.

Gurwitz points out four pitfalls in the high tech redevelopment plans. They include: (1) a concept, i.e., "high tech," which has such broad usage as to be rendered essentially meaningless; (2) a universal appeal which high tech industry has as a desirable new "resident" in the community; yet many communities, simply by virtue of the massive proliferation of these economical development plans across the country, are bound to leave some efforts doomed to disappointment; (3) a local, prestigous engineering university--so important to the high tech industry--that can compete with the MITs and Stanfords will leave many communities far down the ladder of competitiveness in recruiting high technology firms; and (4) the multiplicity of reasons that determine where industries choose to locate often are based on factors over which local units, be they governmental or civic, have little or no influence and, hence, the community is left with minimal certainty of recruiting new industry to town.

Two popular responses made by localities to encourage high tech immigration are specialized training programs and civic seed-capital funds. As Gurwitz poignantly asks, however, are the graduates of the training likely to stay home or might they migrate elsewhere; and, secondly, if the quality of the proposed new industry "is not high enough to attract the traditional sources" of capital investment, "why should public or civic funds be spend on them?" (24)

The attention of this review has been on the national scene. This review shall now turn to the state and local scene to analyze the impact

of the national influences on the local economy, as well as the unique features of the area.

## TOLEDO AREA-BASED MANUFACTURING SECTOR

Developments in the larger heartland area that have led to the present economic struggles is particularly true of Ohio and the Greater Toledo Area. After having developed heavily in the automobile and automobile parts supplier industries, this area's economic base met a major snag when the foreign, particularly Japanese, auto industry made significant inroads into American imports. The result is one of the highest unemployment rates in the country in 1982. Increasingly, Ohio's economy is discovering that a world marketplace has emerged in the last decade in which nobody hesitates to look all over the world for their products. Traditional markets can no longer be taken for granted. This can be illustrated, for instance, by Minnesota which is presently facing stiff competition with Northern England in producing heavy farm machinery at one-third to one-half the labor rates paid to Minnesotians. Another example is the shipbuilding industry which first moved from the U.S. to Japan and is now in a second major readjustment move to South America. (7:8)

### Decline of the Manufacturing Sector

There is a growing reservoir of data that demonstrates the losing struggle the local area economy faces in the midst of these fundamental readjustments of the world economy. For example, comparisons of the per capita income of Toledoans to national averages over a spread of 21 years (1959 to 1980) shows a marked percentage change from 105.2 percent to 99.8 percent of the U.S. Average. (See Table 1.1)

TABLE 2.1
A COMPARISON OF PER CAPITA INCOME IN TOLEDO SMSA WITH OHIO AND U.S.
FOR SELECTED YEARS

| | 1959 | 1965 | 1969 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|
| Personal Income (in million $) | 1,562 | 2,077 | 2,874 | 5,135 | 5,689 | 6,246 | 6,895 | 7,541 |
| Per Capita Income | 2,256 | 2,867 | 3,807 | 6,638 | 7,349 | 8,070 | 8,962 | 9,505 |
| As % U.S. Average | 105.2 | 104.3 | 103.8 | 103.8 | 104.5 | 102.9 | 102.3 | 99.8 |
| As % Ohio Average | 100.2 | 100.4 | 100.8 | 103.8 | 103.7 | 102.7 | 102.9 | 100.5 |

DATA FROM: Bureau of Economic Analysis, U.S. Department of Commerce.

Nearly 30 percent of the Toledo breadwinners in 1980 are employed in manufacturing industries, yet this is the same employment classification which the Bureau of Employment Services has classified as vulnerable and susceptible to the cyclical nature of the economy.

This trend can be further demonstrated by a comparison of a national unemployment rate to the Toledo unemployment rate during a period of economic expansion. A 5.8 percent average in the United States during a growth period will compare with a Toledo SMSA unemployment rate in the same period of 6.1 percent. On the other hand, during a period of recession when Toledo's unemployment rate is at 10 percent, the national average will be 7.7 percent. (42:14-16) Table 2.2 compares the unemployment figures for Toledo with both Ohio and the U.S. from 1970 to 1981. The 1970 unemployment rate for Toledo was 5.5 as compared to the U.S. of 4.9. The 1980 figure was 10.8 versus 7.6. While employment grew from 298,400 to 327,300 in Toledo, the unemployed workers were 17,400 in 1970 as compared to 39,600 in 1980. This increase in the unemployed more than doubled the number of unemployed at the beginning of the decade. (See Table 2.2)

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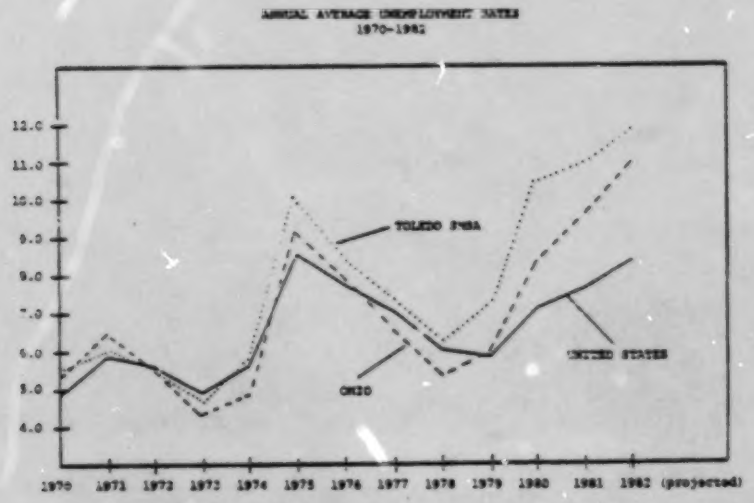
TABLE 2.2
EMPLOYED AND UNEMPLOYED STATISTICS FOR THE
TOLEDO SMSA, OHIO AND U.S., 1970-1981

| Year | Civilian Labor Force | Total Employed | Total Unemployed | Unemployment Rate Toledo SMSA | Ohio | U.S. |
|---|---|---|---|---|---|---|
| 1970 | 315,800 | 298,400 | 17,400 | 5.5 | 5.3 | 4.9 |
| 1971 | 319,300 | 300,300 | 19,100 | 6.0 | 6.5 | 5.9 |
| 1972 | 329,400 | 311,300 | 18,100 | 5.5 | 5.5 | 5.6 |
| 1973 | 339,800 | 324,200 | 15,600 | 4.6 | 4.3 | 4.9 |
| 1974 | 343,800 | 324,200 | 19,700 | 5.7 | 4.8 | 5.6 |
| 1975 | 344,800 | 310,200 | 34,600 | 10.0 | 9.1 | 8.5 |
| 1976 | 347,300 | 318,500 | 28,800 | 8.3 | 7.8 | 7.7 |
| 1977 | 353,900 | 328,500 | 25,400 | 7.2 | 6.5 | 7.0 |
| 1978 | 361,200 | 338,800 | 22,400 | 6.2 | 5.4 | 6.0 |
| 1979 | 366,400 | 340,100 | 26,300 | 7.2 | 5.9 | 5.8 |
| 1980 | 367,500 | 329,300 | 38,200 | 10.4 | 8.4 | 7.1 |
| 1981 | 366,900 | 327,300 | 39,600 | 10.8 | 9.6 | 7.6 |

NOTES: Subtotals may not add due to rounding.
DATA FROM: Division of Research and Statistics, Ohio Bureau of Employment Services

During the 70s, the national average of new jobs created in a populous area the size of the Toledo SMSA was 42,300, while the actual number of new jobs which were created during that timeframe in Toledo was only 31,100. Table 2.3 illustrates the disparity of Toledo's unemployment as compared to Ohio and the U.S.

TABLE 2.3

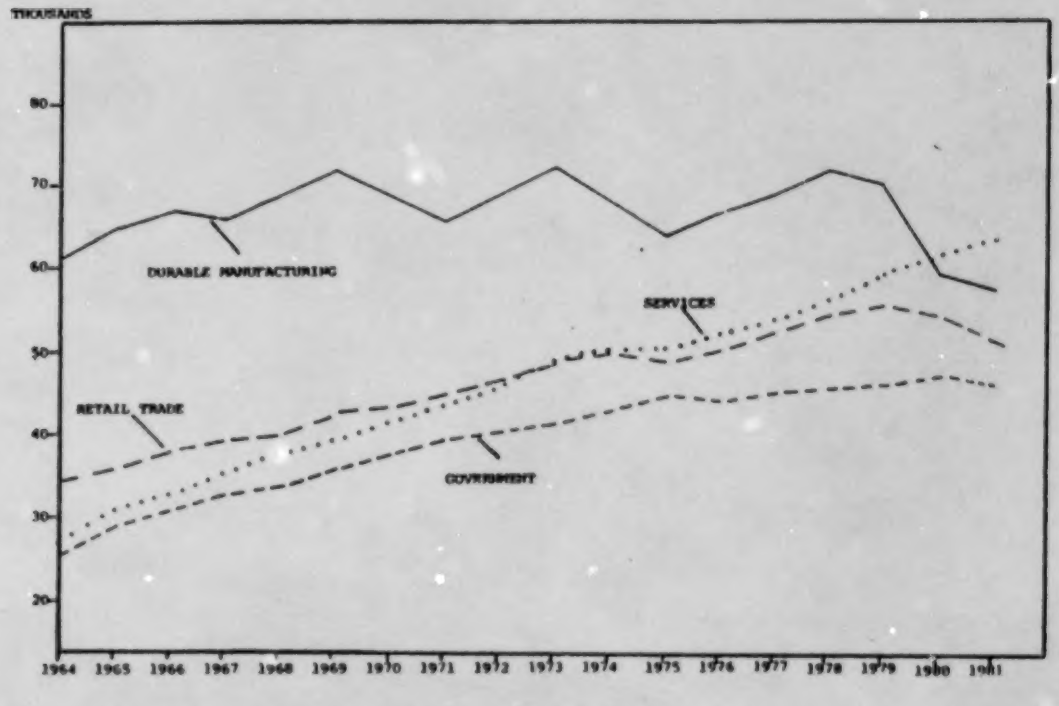



DATA FROM: Division of Research Statistics, Ohio Bureau of Employment Services.
Special Grants Office, Ohio Bureau of Employment Services.
Business Forecasts 1982, Federal Reserve Bank of Richmond.

One of the important dynamic changes in Toledo's workforce, which mirrors the shift referred to earlier on the national scene, is that non-manufacturing jobs in the 70s increased by 24.9 percent while the percentage of manufacturing jobs decreased by only 17.2 percent. (42:10) Table 2.4 illustrates graphically the relative strength of the employed by categories of manufacturing, retail trade, services, and government workers. In 1960 manufacturing employment represented 40.2 percent of the state of Ohio. Today it is less than 30 percent.

TABLE 2.4

NONAGRICULTURE WAGE AND SALARY EMPLOYMENT
IN TOLEDO METROPOLITAN AREA 1964-1981




SOURCE: ONES Nonagriculture Wage and Salary Employment MS 790 (1964 to 1981)

This manufacturing/non-manufacturing trend is clearly illustrated in a shift-share analysis of the local employment level. This comparative technique demonstrates the relative strength of particular industries and local economic conditions to the national base. (See Table 2.5)

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TABLE 2.5

SHIFT SHARE
TOLEDO SMSA: SUMMARY ANALYTICS
1975-1981

| | NATIONAL EMPLOYMENT (1,000s) | | NAT'L CHANGE | COMPONENTS OF CHANGE | | | LOCAL EMPLOYMENT (1,000s) | | LOCAL CHANGE |
|---|---|---|---|---|---|---|---|---|---|
| INDUSTRY | 1975 | 1981 | % | NAT'L SHARE | IND. MIX | LOCAL SHARE | 1975 | 1981 | % |
| Construction | 3,525.0 | 4,307.0 | 22.1 | 2.44 | .10 | - 2.54 | 11.5 | 11.5 | 0.0 |
| Manufacturing | 18,323.0 | 20,261.0 | 10.6 | 17.11 | -8.56 | -15.25 | 80.7 | 74.0 | - 8.3 |
| Food | 1,657.5 | 1.684.1 | 1.6 | 1.00 | - .92 | - .57 | 4.7 | 4.2 | -10.6 |
| Stone/Clay/Glass | 629.0 | 667.0 | 6.0 | 2.99 | -2.14 | - 1.95 | 14.1 | 13.0 | - 7.8 |
| Metals/Machinery | 6,355.7 | 7,358.3 | 15.8 | 4.40 | -1.12 | - 4.99 | 20.8 | 19.1 | - 8.2 |
| Trans. Equipment | 1,715.0 | 1,837.8 | 7.2 | 4.10 | -2.70 | - 3.88 | 19.2 | 16.7 | -13.0 |
| *Other Manufacturing | 8,477.5 | 8,713.8 | 2.8 | 4.64 | -4.03 | - 1.51 | 21.9 | 21.0 | - 4.1 |
| Trans. & Utilities | 4,542.0 | 5,151.0 | 13.4 | 3.79 | -1.40 | - 2.39 | 17.9 | 19.2 | 7.3 |
| Wholesale Trade | 4,415.0 | 5,343.0 | 21.0 | 3.10 | - .00 | - 3.00 | 14.6 | 14.7 | .7 |
| Retail Trade | 12,645.0 | 15,395.0 | 21.7 | 10.30 | .24 | 7.50 | 48.4 | 51.4 | 6.2 |
| F.I.R.E. | 4,165.0 | 5,331.0 | 27.9 | 1.90 | .60 | - .90 | 9.0 | 10.6 | 17.8 |
| Services | 13,892.0 | 18,598.0 | 33.9 | 10.60 | 6.40 | - 3.60 | 50.1 | 63.5 | 26.7 |
| TOTAL | 62,268.0 | 75,489.0 | 21.2 | 49.23 | 0.00 | 36.50 | 232.2 | 244.9 | 5.5 |

*Includes Tobacco, Petroleum, Rubber & Plastics, Leather, Furniture & Fixtures, Paper and Allied Textiles, Lumber & Wood, Printing, etc.

SOURCES: U.S. DOL-BLS; Ohio ES, Research and Statistics

This shift-share table suggests that the local economy is weaker than the national economy as a whole. Changes in the local employment level result from or are influenced by (1) national economic growth, (2) the strength of specific industries, and (3) local economic forces. The shift-share analysis isolates each factor and identifies its effect on sectors of industries. A minus (-) sign in the table suggests the combination of these factors result in a slower growth of an industry sector in the local economy. The columns for "Industrial Mix" and "Local Share" show negative percentages in all industries except three: retail trade, F.I.R.E., and services. The weakest sector is manufacturing, showing a -8.56 industrial mix and -15.25 local share. To see change relative to expectations in future developments, one compares the percent of "Local Change" to "National Change." While positive percentages occur in all sectors of the national base (although manufacturing shows the smallest increase of the seven major industries), the Toledo change warns of serious complications for the local economy. Manufacturing alone shows negative growth with an overall decline of -8.3 percent and a -13.0 percent in transportation equipment, one of the major segments of Toledo's manufacturing industry.

The Ohio Bureau of Employment Services (OBES) predicts a modest increase in manufacturing employment between 1982 and 1985 of 8 percent. This is compared to an expected increase of 13.3 percent in the non-manufacturing sector.

The manufacture of durable goods (as distinct from "non-durable goods") is the primary role of all manufacturing in Ohio, with two-thirds of the manufacturing employment represented in durable and only one-third in the non-durable goods. Of all industries in durable manufactur-

ing, 60 percent are in the six SIC groups of glass, primary metal, fabricating, machining, electrical equipment, and transportation. Table 2.6 compares the percentage decline for the state of Ohio in employment wages in 1980 to 1979 for workers in these five industries. The range is from 74.6 to 93.4 percent of the levels in 1970 by 1980. (See Table 2.6)

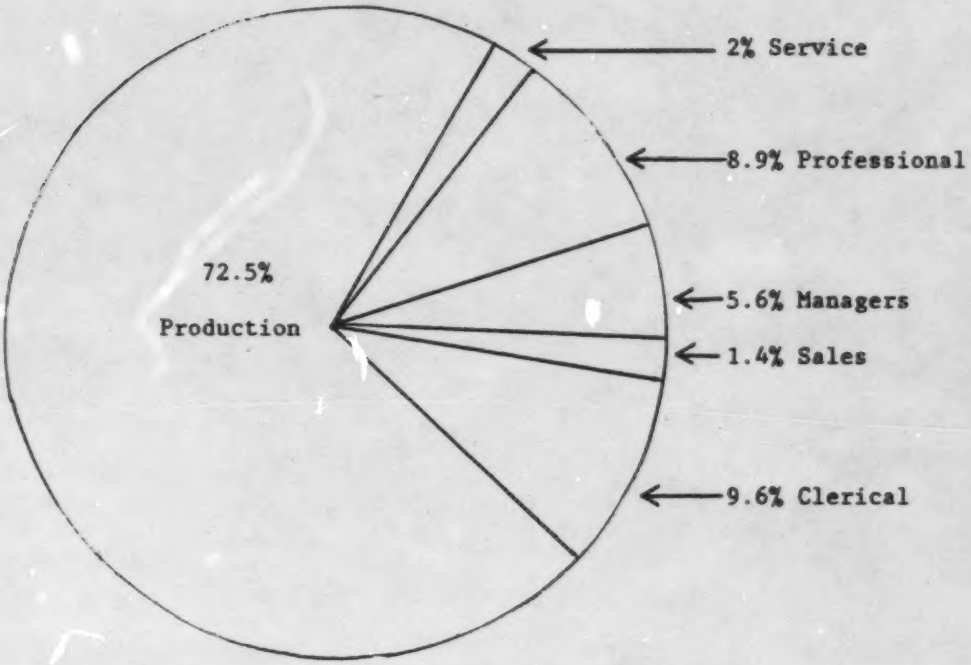
TABLE 2.6
MANUFACTURING WAGE AND SALARY EMPLOYMENT
STATE OF OHIO

| | Percent | 1980 Average in Thousands | 1970 Average in Thousands | Percent Change 1980/1970 |
|---|---|---|---|---|
| Total Manufacturing | 100.0 | 1267.5 | 1409.9 | 89.9 |
| Durable Goods | 69.8 | 885.2 | 1002.5 | 88.3 |
| Glass | 5.1 | 64.6 | 69.9 | 92.4 |
| Primary Metal | 11.0 | 139.6 | 168.2 | 83.0 |
| Fabricated | 12.0 | 157.5 | 170.2 | 92.5 |
| Machinery except Electrical | 16.9 | 213.8 | 228.9 | 93.4 |
| Electric-Electronic Equipment | 8.5 | 107.6 | 144.3 | 74.6 |
| Transportation and Equipment | 10.9 | 138.7 | 152.9 | 90.7 |

Occupational Profiles in Ohio Manufacturing, 1980, p.v.

In 1980 the OBES reports that 842,300 workers in these six industries are classified as production workers, or 72.5 percent, with the balance classified as managers, professional/technical, service, clerical and sales. The clerical workers make up the second largest occupational group in these five industries. (See Table 2.7)

TABLE 2.7
1980 DURABLE MANUFACTURING EMPLOYMENT IN OHIO
BY MAJOR OCCUPATIONAL CATEGORY




| SIC | Managers and Officers | Professional and Technical | Service Workers | Maintenance and Productions | Clerical and Related | Sales |
|---|---|---|---|---|---|---|
| 32 | 16.3 | 6.7 | 1.7 | 75.5 | 8.1 | 1.8 |
| 33 | 2.9 | 4.6 | 1.8 | 82.1 | 7.8 | 10.8 |
| 34 | 5.9 | 17.3 | 2.0 | 73.7 | 9.5 | 1.7 |
| 35 | 7.6 | 11.5 | 1.7 | 66.1 | 11.6 | 1.7 |
| 36 | 5.7 | 13.0 | 1.9 | 70.3 | 9.0 | 1.1 |
| 37 | 4.3 | 9.7 | 2.7 | 74.5 | 8.1 | .7 |

Source: 1980 Ohio Occupational Employment Survey

The shift in the state of Ohio's industry employment from manufacturing to non-manufacturing, noted in Table 2.6, is mirrored by the employment figures of Toledo's industry. Table 2.8 compares an eleven-year trend in manufacturing and non-manufacturing sectors. While the total employment increased from 263,100 to 290,900, manufacturing decreased from 89,400 to 74,000, or 15,400 fewer workers while non-

## TABLE 2.8

TOTAL NONAGRICULTURAL MANUFACTURING AND NONMANUFACTURING EMPLOYMENT
IN THE TOLEDO SMSA
1970 - December, 1981
In Thousands

| YEAR | TOTAL NON-AGRI-CULTURAL | MANUFAC-TURING | DURABLE GOODS | NON-DURABLE GOODS | NON-MANUFAC-TURING | MINING | CONSTRUC-TION | TRANSPOR-TATION & UTILITIES | WHOLE-SALE TRADE | RETAIL TRADE | FINANCE INSURANCE & REAL ESTATE | SERVICES | GOVERNMENT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 263.1 | 89.4 | 68.5 | 20.9 | 173.7 | .5 | 10.6 | 18.9 | 13.6 | 42.8 | 8.3 | 41.1 | 37.9 |
| 1971 | 263.7 | 86.2 | 65.4 | 20.9 | 177.4 | .5 | 10.6 | 19.1 | 13.3 | 44.6 | 8.4 | 42.4 | 38.5 |
| 1972 | 272.4 | 88.8 | 67.5 | 21.3 | 183.6 | .5 | 11.6 | 19.0 | 13.4 | 47.0 | 8.6 | 43.5 | 39.8 |
| 1973 | 285.8 | 93.4 | 72.3 | 21.1 | 192.4 | .6 | 13.1 | 19.5 | 13.9 | 49.2 | 9.0 | 46.4 | 40.8 |
| 1974 | 285.6 | 89.8 | 69.6 | 20.2 | 195.8 | .6 | 13.4 | 19.3 | 14.4 | 49.3 | 9.2 | 48.1 | 41.5 |
| 1975 | 275.5 | 80.7 | 62.3 | 18.4 | 194.7 | .6 | 11.5 | 17.9 | 14.6 | 48.4 | 9.0 | 50.1 | 42.6 |
| 1976 | 282.6 | 84.8 | 65.9 | 18.9 | 197.8 | .6 | 11.4 | 18.6 | 14.5 | 49.9 | 9.2 | 51.5 | 42.1 |
| 1977 | 291.9 | 88.2 | 68.8 | 19.4 | 203.7 | .6 | 11.3 | 19.5 | 14.5 | 51.0 | 9.7 | 53.4 | 43.7 |
| 1978 | 301.4 | 91.0 | 71.2 | 19.8 | 210.4 | .6 | 11.8 | 20.4 | 14.6 | 53.2 | 10.0 | 55.5 | 44.2 |
| 1979 | 307.2 | 89.0 | 70.0 | 18.9 | 218.2 | N/A | 11.9 | 21.4 | 15.0 | 54.1 | 10.5 | 59.3 | 45.5 |
| 1980 | 294.2 | 74.9 | 57.7 | 17.2 | 219.3 | N/A | 13.1 | 20.0 | 14.6 | 52.6 | 10.8 | 60.3 | 47.4 |
| 1981 | 290.9 | 74.0 | 57.3 | 16.7 | 216.9 | N/A | 11.5 | 19.2 | 14.7 | 51.4 | 10.6 | 63.5 | 45.6 |

SOURCE: Division of Research and Statistics, Ohio Bureau of Employment Service

manufacturing employment increased from 173,700 to 216,900. This latter gain of 43,200 was nearly triple the number of lost jobs in manufacturing. Of the two manufacturing classifications, durable and non-durable, the most serious losses occurred in durable manufacturing, i.e. those industries which are the subject of this study. A total of 11,200 jobs were trimmed from the local durable manufacturing payrolls. The eleven-year peak employment of the durable manufacturing sector came in 1978 when there was a total of 71,200 employed. The loss in 1980 and 1981 was a dramatic reduction of 12,700 jobs.

The decline, noted in Table 2.6 and Table 2.8 above, is reflected in the number of firms located in the Toledo area in the major six manufacturing industries of glass, primary metal, fabrication, machining, electrical, and transportation. While there was an increase in the total number of firms from 535 in 1972 to 591 in 1979, that increase is tempered by the fact that the firms had a fewer number of employees. There was an additional 22 firms with 1-19 employees and a -4 decline of firms with 500+ employees. (See Table 2.9)

TABLE 2.9
ESTABLISHMENTS AND EMPLOYMENT SIZE DISTRIBUTION BY INDUSTRY
TOLEDO METROPOLITAN AREA

| | | 1972 | | | | | 1979 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SIC | INDUSTRY | Total Estab. | 1-19 | 20-99 | 100-499 | Over 500 | Total Estab. | 1-19 | 20-99 | 100-499 | Over 500 |
| 32 | Glass | 71 | 35 | 16 | 15 | 5 | 74 | 46 | 13 | 10 | 5 |
| 33 | Primary | 45 | 20 | 13 | 7 | 5 | 53 | 15 | 24 | 10 | 3 |
| 34 | Fabricated | 137 | 72 | 47 | 16 | 2 | 170 | 85 | 55 | 28 | 2 |
| 35 | Machinery | 213 | 151 | 51 | 6 | 5 | 223 | 148 | 60 | 12 | 3 |
| 36 | Electrical | 27 | 13 | 10 | 3 | 1 | 29 | 15 | 9 | 3 | 2 |
| 37 | Transportation | 42 | 13 | 14 | 7 | 8 | 43 | 17 | 11 | 8 | 7 |
| | | 535 | 304 | 151 | 54 | 26 | 592 | 326 | 172 | 71 | 22 |

| Number of Employees | Number of Firms 1972 | Number of Firms 1979 | Increase/ Decrease +(-) |
|---|---|---|---|
| 1-19 | 304 | 326 | 22 |
| 20-99 | 151 | 172 | 21 |
| 100-499 | 54 | 71 | 17 |
| Over 500 | 26 | 22 | (4) |
| Total | 535 | 591 | |

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Translated into numbers of employees, the Ohio Bureau of Employment Services reports a 24.9 percent increase in non-manufacturing employment and a 17.2 percent decrease in manufacturing employment between 1970 and 1981. Table 2.10 shows the decline in the percentage proportion of the total employment by industry, with manufacturing declining from 31.4 to 25.8 percent of the workforce in the Toledo area from 1974 to 1985.

TABLE 2.10
NONAGRICULTURAL EMPLOYMENT BY MAJOR INDUSTRY
ACTUAL AND PROJECTED, 1974 - 1985

TOLEDO SMSA

| | Percent of Distribution | | | | |
|---|---|---|---|---|---|
| INDUSTRY | 1974 | 1976 | 1979 | 1980 | 1985 |
| Total | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| Manufacturing | 31.4 | 30.0 | 29.0 | 25.5 | 25.8 |
| Durable Goods | 24.4 | 23.3 | 22.8 | 19.6 | 20.2 |
| Nondurable Goods | 7.0 | 6.7 | 6.2 | 5.9 | 5.5 |
| Nonmanufacturing | 68.6 | 70.0 | 71.0 | 74.5 | 74.2 |
| Mining | .2 | .2 | .2 | .2 | .2 |
| Construction | 4.7 | 4.0 | 3.9 | 4.5 | 4.2 |
| Transportation & Utilities | 6.8 | 6.6 | 7.0 | 6.8 | 6.6 |
| Trade | 22.3 | 22.8 | 22.5 | 22.8 | 22.7 |
| Finance, Insurance & Real Estate | 3.2 | 3.3 | 3.4 | 3.7 | 3.8 |
| Services | 16.8 | 18.2 | 19.3 | 20.5 | 21.8 |
| Government | 14.5 | 14.9 | 14.8 | 16.1 | 14.6 |

NOTE: Totals may not add due to rounding

DATA FROM: Division of Research and Statistics, Ohio Bureau of Employment Services.

Employment and Earnings, Bureau of Labor Statistics, U.S. Department of Labor.

Valerie A. Personick, "The Outlook for Industry Output and Employment through 1990," Monthly Labor Review, Bureau of Labor Statistics, U.S. Department of Labor, (August, 1981), pp. 28-41.

Summary

As indicated at the beginning of this section, there has been a growing reservoir of data that suggests a fundamental decline in the local area economy. The review of the literature not only confirmed this observation, but placed considerable doubt on the future viability of the local manufacturing sector which has had a significant role historically in this community.

This report now turns to a revolutionary new development in the manufacturing world which promises to forever change the face of the factory environment while at the same time, foisting enormous dislocations of economic and social resources and stability. This new development is the application of high technology to the manufacturing processes.

## PROSPECTS FOR COMPUTER-INTEGRATED MANUFACTURING

Change has characterized the whole of human history; two variables of change are their rapidity in a given period of time and within a given sector of society. Although this comment may sound trite, the fact of the matter is the pace of change in the 70s and 80s that is occurring in the manufacturing sector as a result of the introduction of electronics and the computer to the production processes is so great that the change might be viewed as revolutionary rather than as evolutionary.

This point was made by a number of authors reviewed in this study. James Cook, for instance, wrote in an article entitled "The Molting of America" and published in Forbes" that the U.S., indeed the entire industrial world, is profoundly changing the way it uses men and materials, capital and manufacturing processes. We are undergoing what economists call a structural change, touched off by a spurt in energy

prices but stemming from even more fundamental causes." (13:161) As Fred Zieber of Dataquest has indicated, the pressure to pursue the electronic path is so intense that one cannot hold back the change anymore than one can hold back Pac Man. (13:166) David Snyder notes that within the span of the next ten years the electronic automation will "directly affect every level of every public and private enterprise in America." (52) Another futurist, W. Clyde Helms, in commenting on these pending changes, anticipates the development in a very short period of time of technologies for which no name exists today. Some of the most important new technologies of the 21st century his "occupational forecasting" methodology has identified are related to communications, computers, robotization, biotechnology, electric power generation storage, fuels technology, materials technology and body technologies. (28)

Implementation of Automated Equipment

The progress and quickening pace in automating the production processes to date is impressive. A survey by a trade publication, Production, in December, 1981, shows that 53.8 percent of plants involved in manufacturing are currently operating numerically controlled (NC) machinery. This was a 6 percent increase in only one year. Furthermore, half of those plants surveyed indicated they were adding new purchases of NC systems within the next year. The Production article proceeds to predict that by 1990 nearly 75 percent of the U.S. machine tool population will be under either computer numerical control or direct numerical control. (43:64)

Similar to the NC field, the robot population grew from 200 in 1970 to 4,500 in 1982, although 30 percent of this population was owned by only six firms. The Arthur D. Little Service predicts an average annual

increase until 1992 in robotics of 28 percent to a total investment of $2.1 billion. (9) The Society of Manufacturing Engineers estimates that these robots will be distributed in 1990 by the following percentage proportions: intelligence robots, 30 percent; universal robots, 28 percent; other programmable robots, 26 percent; and fixed-routine robots, 16 percent. (50:12)

Another development similar to NC and robotics in automated equipment is CAD/CAM which has expanded greatly in the past few years. Roy M. Salzman of the Arthur D. Little Service projects three significant influences on this expansion; (1) sharply lower computer costs, (2) availability of appropriate software, and (3) "the realization on the part of senior management that computer technology can, indeed, improve the productivity of engineering and manufacturing activities." (47:1)

Productivity Impact

Certainly productivity has become a focus of attention in the competition of a world-wide market. Productivity rates are determined by a number of variables, including the nature, skill-level and competence of the labor force, the capital investment, federal, state and local regulation impact, worker attitude, and various other social and institutional factors. The real "gains in productivity--and profitability-can be accomplished," claims an Arthur D. Little publication, "through carefully balanced mixes of new tools and management techniques; and maximum results will come from their integration into modern manufacturing management systems." (6:11)

General Motors, to select but one illustration, currently has 425 robots working in its plants with 5,000 expected by 1985 and 14,000 by 1990. The productivity gains anticipated by General Motors are to be 50 percent in the next decade.

The changing industrial scene as a result of its automation is described by Helms as being nothing short of an "industrial renaissance" with productivity increases of 20 percent as normal, which he illustrates by noting Datsun's Zamar assembly plant that employs 67 workers and builds 1,300 cars a day. (27:8) As robots become "intelligent," that is able to select from an array of alternatives, the potential is even more intriguing. A robot at the Charles Stark Draper Laboratories in Massachusetts is able to assemble a 17-piece automobile alternator in 2 minutes and 42 seconds. (27:8) The Arthur D. Little Service predicts that Computer-Aided Engineering (CAE) systems will grow at an estimated 25 annual percentage points, and the productivity improvement will be an average of 4:1 in the design/drafting applications of CAE. (47:7)

Description of Components of High Technology in Manufacturing

The application of the computer and automation to the manufacturing process has many facets. In interpreting the impact on production, definitions of the various applications of automation is helpful. This study uses the term "Computer-Aided Engineering" (CAE) as an inclusive designation of the application of automation to the entire manufacturing process. This term includes the popularized "CAD/CAM" (computer-aided design and computer-aided manufacturing of design, drafting, and NC machine tool tape preparation), but CAE also includes a broader spectrum of engineering functions, such as industrial, facilities, and reliability engineering. CAE is "the direct application of specialized hardware or software to product design, drafting, and manufacturing activities." (47:13)

The application of computers on the factory floor to control equipment for the fabrication, assembly, movement and inspection of machined parts falls into five categories: numerically-controlled machine tools;

robots; automated materials handling equipment; programmable controllers; and integrated manufacturing systems.

Under the rubric of numerically-controlled machine tools is the machine tool that can be programmed by a punched tape. This type of machine represents 25 to 30 percent of all tools shipped today. An NC machine is capable of a production efficiency of 3 to 10 times more output per unit of time as compared to an earlier generation of manually-operated machines. Further, among its efficiencies is included a better quality product, less tooling cost and, often, less floor space. (47:25)

Akin to the NC tool is the "CNC," that is, computerized numerically controlled. This sophisticated advancement provides for a stored program in a computer dedicated for the tool. A DNC, that is a "directly numerically controlled" tool, is programmed and controlled by a central computer. One major advantage of the DNC over the CNC is that while the CNC is being programmed by a programmer the tool is out of production. A DNC program can be written and inputted during production time of the tool through a central computer.

The current state-of-the-art of robots afford a three-category definition: (1) pick and place (used to augment the strength of a person); (2) general purpose (more sophisticated than pick and place, such as spot weld, screw screws, etc.); and (3) closed-loop (employs a feedback system for accurate positioning and using optical, tactile or heat-sensing to inform the control system of the proper positioning). (47:27-28)

Computer-aided design and computer-aided manufacturing is defined as the "direct application of specialized hardware or software to product and manufacturing engineering and manufacturing operations." (47:1) There are eight engineering functions related to CAD/CAM systems: design layout; design analysis; manufacturing engineering; fabrication

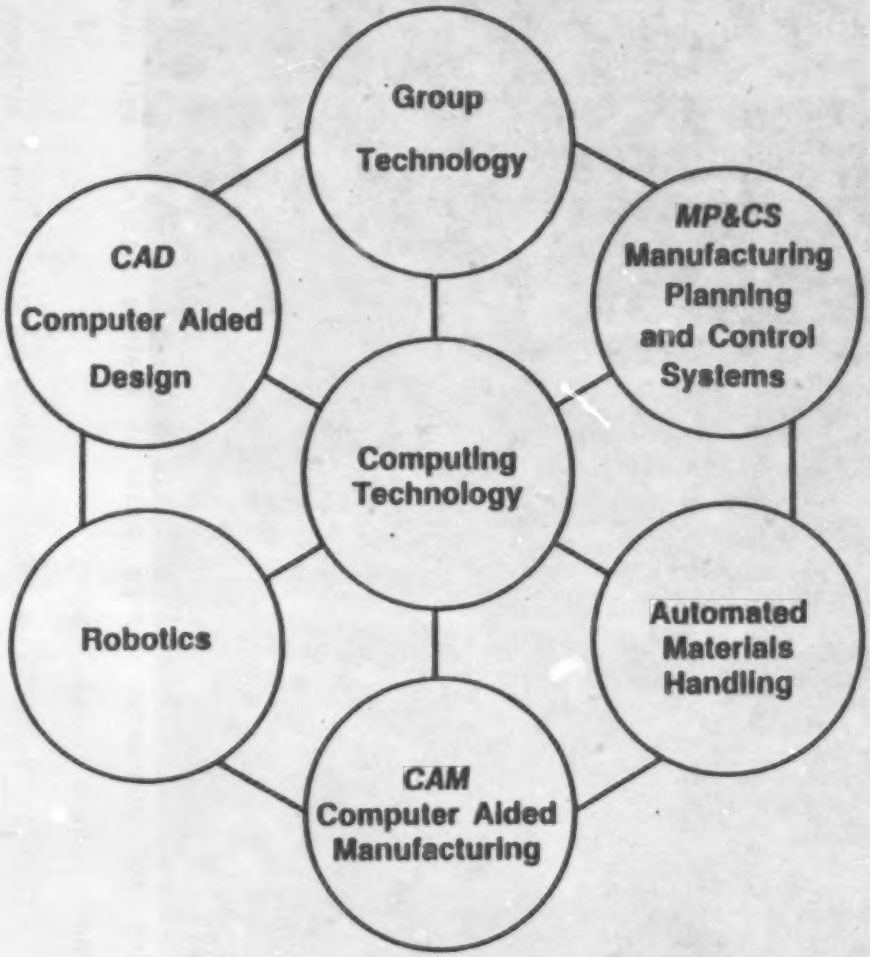
automation; assembly automation; materials handling; industrial engineering; and quality assurance. Following is the distribution by CAD/CAM-user groups of industries (47:14):

| | |
|---|---|
| aerospace/ordnance | 30 percent |
| automotive/mobile equipment | 25 percent |
| electronics | 25 percent |
| mechanical products | 10 percent |
| construction/architecture | 5 percent |
| civil engineering | 2 percent |
| other | 3 percent (48:14) |

The Emergence of Computer-Integrated Manufacturing

Increasingly, the systems described above are being integrated, interwoven, and expanded into even more complex configurations that lead to what popularly is called the "automated factory," or the "Factory of the Future." Following the Arthur D. Little Service conceptualization of these interfacing components, this study identified seven functional areas of the Computer-Integrated Manufacturing's Factory of the Future. Many of these functional areas are already in place and running in factories throughout the world today. Conceptually, these seven areas have an interrelationship as follows:

# COMPUTER INTEGRATED MANUFACTURING



The definition by Arthur D. Little, Inc., of each functional area has been adopted by this study. The definitons are:

COMPUTER-AIDED DESIGN (CAD)--Includes four major functions: computer-aided design itself; computer-aided engineering (CAE), which includes all of the analytical software used to analyze part designs; computer-aided process planning; and numerically controlled (NC) part programming.

GROUP TECHNOLOGY (GT)--Comprises parts-related classification and coding, along with the process-related function of grouping machines into manufacturing cells to produce families of parts.

MANUFACTURING PLANNING AND CONTROL SYSTEMS (MPCS)--encompasses manufacturing resources planning (MRP), distribution resource planning (DRP), standard cost reporting, simulation and/or optimization software, shop floor data collection, decision-support software, manufacturing management graphics, preventive maintenance software, and other similar types of software.

AUTOMATED MATERIALS HANDLING (AMH)--Includes traditional materials handling equipment such as pallet racks, conveyers and storage bins and automatic storage retrieval systems (AS/RS) and automatic guided vehicle systems (AGVS).

COMPUTER-AIDED MANUFACTURING (CAM)--Covers at least five major functions: Numerically controlled machine tools, flexible manufacturing systems (FMS); process control devices such as programmable controllers and microprocessors; automated assembly; and computer-aided inspection.

ROBOTICS--Stand-alone robots reflect an industry in its early stages of development. The future robotics industry will place increasing

importance on linking and controlling multiple robots by computer software.

COMPUTING TECHNOLOGY--Is the integrator of the major manufacturing functions. Included are hardware, software, data base, and telecommunications.

Toledo and Computer-Integrated Manufacturing

As noted in the introduction of this paper, (see page 2), one of the primary purposes of this project was to conduct a survey of the local manufacturing industry. This survey was intended to ascertain the level of implementation of high technology as described above in the area industry at the present time and to project the potential expected in a five-year span of time. Manpower availability was a second major concern of the survey project.

The balance of this paper describes (1) the methodology of carrying out this survey project, (2) reports the results of the survey, and (3) draws summary conclusions from this study and proposes several recommended actions for the Private Industry Council to consider.

# CHAPTER 3

# METHODOLOGY

The methodology of this survey project was initiated with the establishment of a task force representing the manufacturing corporate structures based in the Toledo area, educational institutions, the Chamber of Commerce, the Private Industry Council, the UAW, and a major real estate developer. The role of this task force was to monitor and advise the project director in the process of the survey.

The project director reviewed the literature on community and regional studies on high technology. The two community projects reviewed were Dayton and Columbus, Ohio, each having been sponsored by their respective local Chamber of Commerce. The Dayton study identified the current level and potential growth of high technology in electronics and measurement instruments in the Dayton area as a result of the "incubator" influence of the Wright Patterson Air Force Base. A report, Economic Analysis and Policies for Growth Electronic Components and Measurement Instruments, was published. (13) The Columbus survey was an attempt to identify and develop a complete list of high tech firms in the Columbus area and characteristics of the nature of those firms; i.e., research, user, manufacturer, etc.

Four state-level studies were reviewed. One of them was a project of the State Department of Education of Georgia (56); a second was the Michigan state government developmental plan; a third was the activities to encourage high technology by the Department of Commerce of the state of Pennsylvania; and the fourth was the Department of Economic and Community Development of the state of Ohio. In all four cases, visits were made by the researchers for on-site review.

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Two federally-funded projects were investigated. One was a published report of a joint congressional committee entitled "Location of High Technology Firms and Regional Economic Development." (51) The second was a personal interview by the researchers in Detroit, Michigan, with Ms. Degoff of the Congressional Office of Technology Assessment which was sponsoring a national review of activity in high technology. Among numerous other contacts made in this project were several meetings with the research office of the Society of Manufacturing Engineers; the Development and Planning Office of Libbey-Owens-Ford Company; staff members of the Arthur D. Little, Inc.; and Mr. Mark Schaff, State Department of Education, Ohio, who, in cooperation with the Ohio State University, is project manager of the staffing patterns projections of both the state of Ohio and the Toledo area.

One of the early decisions required to conduct this survey was to determine the survey methodology to be employed. An important goal of the survey was to identify potential manpower needs to support current industry expansion in high technology and projected new industry to be established in a three- to five-year period of time. The literature in this field that applied to the methodology of identifying manpower levels and projections is competently reviewed in two important articles. The first, published in 1967, was written by Norman Medvin (37), and the second, authored by Harvey A. Goldstein (23), is one of the most recent definitive statements on manpower projections. In addition to the fact that an employer survey to identify forecasts of number of employees was not only resoundingly rejected in this literature review, this project pilot-tested an employer survey on selected local industries and its results confirmed the shortcomings of the employer survey approach for the purposes of this study.

The literature review of survey methodologies or forecasting strategies included the Delphi technique, which has been recently popularized by the Univeristy of Michigan and the Society of Manufacturing Engineers. In this approach, a consensus of opinion from a group of experts in the field, called "panelists," is elicited. Statements are formulated in a questionnaire that project a fact, a forecast, or other benchmark criteria. The panelists are asked to respond to the statement by indicating their degree of agreement to the statement and to write additional reaction comments to the statements. A statistical analysis is made to identify the median response and interquartile range of each question, which denotes the spread and central tendency of the group's ideas. Item statements may also be subsequently amended as a result of the written comments. The revised questions with statistical results of the responses are then distributed again to the panelists for a second response in view of the previous responses by all panelists. The process may be repeated three or four times to develop a "consensus" of the group of experts. A principal advantage of this Delphi technique is that in the repeated surveying process, opinions are reviewed which enables a non-conforming forecast to be judged as more valid and to emerge as a group consensus. This methodology allows and assures a comparable hearing for minority/majority viewpoints without personality dominance or reticence dynamics involved and to identify a statistical group response. Care is taken to assure that panelists are anonymous with one another.

A questionnaire that employed the Delphi method for portions of the questionnaire was developed, distributed to the members of the task force, completed, and returned as a pilot test. The task force subsequently critiqued the instrument and made revisions. The forecast data

used in the questionnaire was adapted from literature published by the Arthur D. Little, Inc. (See questionnaire, Appendix I)

The questionnaire used in the survey employed one fundamental question which typified the Delphi technique. This question requested estimated annual growth percentages for each of seven high tech use areas. The balance of the questions in the survey elicited specific responses to serve as indicators of the degree of high technology applications to the manufacturing process in the Toledo area.

The selection of the panel of experts is an important step in the Delphi process. Several factors influenced the decision to select a stratified sample of firms from which experts would be polled rather than a mailing to a total population of firms. One principal factor was the expected minimal return of a questionnaire distributed to the total population.

A sample of firms was obtained from a compilation of all manufacturing firms in the three-county area by SIC codes. From a total listing of 386 firms, a sample of 60 firms was determined to be representative. Firms were segregated into their two-digit SIC code designations and the names of firms were drawn from each of the six groupings of two-digit SIC codes.

The sources for the listing of firms was the Harris Ohio Marketers Industrial Directory (1982). This listing includes the firm size by number of employees, sales, plant square foot space, the name of the officers of the firm, mailing address, and telephone number. Finally, the Task Force reviewed the random sample for its completeness and representation of Toledo area firms. The Task Force augmented the list with

firms who were major area employers and were known to be significantly committed to implementing high technology in their respective plants and had developed expertise through experience.

An introductory letter under the signature of Mr. J. Michael Porter, Executive Director of the Chamber of Commerce, was mailed to each Chief Executive Officer of firms in the sample. The letter (Appendix II) stated that a subsequent mailing would be made of the survey questionnaire. The Chief Executive Officer was given latitude in assigning the responsibility for completing the survey form to the staff member whom the CEO considered most knowledgeable on the applications of high technology to the manufacturing process.

A follow-up visit by a Task Force member or one of the project researchers was made to each non-respondent. The attempt was made, therefore, to obtain as broad a response as possible.

The statistical analysis of the data called for a mean and quartile distribution of the Delphi question related to an estimate on the degree of implementation of high technology in the Toledo area. The plan was to make additional rounds of the panel if the dispersion was significant. However, this step was not needed because there was a high degree of unanimity in the data.

A statistical analysis was needed for the table on manpower needs. A mean was computed of all responses in each cell. Additionally, to obtain a dispersion factor, an average deviation was computed. This statistic was used in lieu of a standard deviation and was more appropriate due to the limitation of choices the respondent could select, i.e. three choices.

Finally, a mode was computed for each skill in each high tech area. This statistic made possible a more complete perception of the nature of responses and helps to highlight those skill requirements which were perceived to be in critical shortage.

The Task Force received data reports from the researcher on several occasions and met to discuss the results. Implications that could legitimately be drawn from those results were discussed and recommendations were framed to present to the Private Industry Council.

There was a notable difference between the respondent population and the total population based upon size of firm as measured by the number of employees. Following is a breakdown of all manufacturing firms for the Toledo SMSA by number of employees:

TABLE 4.3
SIZE OF FIRMS IN TOLEDO SMSA BY NUMBER OF EMPLOYEES

| EMPLOYMENT RANGE | NUMBER OF MANUFACTURING FIRMS | PERCENTAGE OF TOTAL MANUFACTURING FIRMS |
|---|---|---|
| 1-19 | 326 | 55.2% |
| 20-99 | 172 | 29.1 |
| 100-499 | 71 | 12.0 |
| 500+ | 22 | 3.7 |

The lack of participation by firms who were identified to receive the questionnaire was of concern to the task force. As a consequence, a personal follow-up by a task force member or researcher for the project was made to each of the 33 non-respondents. A variety of reasons accounted for the non-responses. In most instances, however, these non-respondents represented smaller firms, and they declined to participate on the basis that they did not employ high technology at this time, did not anticipate doing so in the future, and/or did not consider anyone in their management to have the expertise necessary to respond to the survey. The response often was, "This survey is not appropriate to our firm."

In addition to the non-response by the smaller firms who received the questionnaire, the pool of firms from which the sample was drawn had been purged of firms with less than 25 employees. Hence, the data of this study had only a minimal reflection of the small firms.

This selectivity became strikingly apparent in comparing the responses to the question concerning whether the respondent believed his

firm would be above, equal to, or below the national average of implementation of high technology over the next five years. Table 4.4 gives a clear confirmation to conventional thought in the literature that the larger firms have greater capability to implement high technology.

TABLE 4.4
ACCUMULATED RESPONSES OF PROJECTED IMPLEMENTATION IN LOCAL FIRMS OF HIGH TECHNOLOGY EQUIPMENT

| NUMBER OF EMPLOYEES | ABOVE NATIONAL AVERAGE | EQUAL TO NATIONAL AVERAGE | BELOW NATIONAL AVERAGE |
|---|---|---|---|
| More than 500 employees | 34 | 30 | 28 |
| Less than 500 employees | 9 | 29 | 35 |

Evaluation of the Data on High Technology Implementation

The questionnaire listed seven major categories of the applications of high technology, as noted in Chapter 2. Each category was identified as a "High Technology Use Area." (See Table 4.5 below.) Definitions of each area can be found on page of this report. Accompanying the use areas were projections or forecasts of the annual percentage growth of each use area through 1987 (see Column 1). These percentages were obtained from the Arthur D. Little, Inc. Columns 2, 3, and 4 of Table 4.5 show the mean of all percentage responses by three groupings, i.e. Column 2 is the percentage of responses by panelists from large firms, Column 3 is the list of panelists from small firms, and Column 4 is the compilation of the two, large and small firms, into one total statistic. The results of the questionnaire show that the panelists anticipated a larger growth pattern for all use areas except CAD and Robotics.

Using the SIC code, the types of manufacturing processes employed in the firms represented by the respondents were as follows:

TABLE 4.1
COMPARISON BY SIC OF PERCENTAGE OF
FIRMS IN SURVEY TO TOLEDO SMSA

| SIC CODE | DESCRIPTION | NO. OF RESPONSES | % OF TOTAL RESPONSES | % OF TOTAL FIRMS IN TOLEDO SMSA |
|---|---|---|---|---|
| 32 | Stone, clay, glass and concrete products | 4 | 14.8% | 27.9% |
| 33 | Primary metal industries | 2 | 7.0 | 8.7 |
| 34 | Fabricated metal products except machinery and transportation equipment | 5 | 18.5 | 14.9 |
| 35 | Machinery, except electrical | 10 | 37.0 | 15.6 |
| 36 | Electrical and electronic machinery, equipment, and supplies | 1 | 3.7 | 8.7 |
| 37 | Transportation equipment | 5 | 18.5 | 25.3 |

Table 4.1 also compares the percentage distribution by SIC codes of firms represented by the respondents to the percentage distribution of all manufacturing firms in the Toledo area. A stratified sample by SIC code and proportional representation by total firms was made in order to solicit data from a panel of experts who had familiarity with the total array of manufacturing processes. This table demonstrates a close relationship of the two distributions by type of manufacturing process.

Following is a breakdown of firms represented by size based on the number of employees:

TABLE 4.2
SIZE OF SURVEYED FIRMS BY NUMBER OF EMPLOYEES

| EMPLOYEE RANGE | PERCENT OF RESPONDENTS | CUMULATIVE PERCENTAGE |
|---|---|---|
| Less than 50 | 25.9% | 25.9% |
| 50 to 499 | 25.9 | 51.8 |
| 500 to 999 | 18.5 | 70.3 |
| 1000 to 1999 | 18.5 | 88.8 |
| 2000 or more | 11.2 | 100.0 |

# CHAPTER 4

## RESULTS OF THE SURVEY

The survey was distributed in December, 1982, to 60 firms which had been identified by the task force to be surveyed. The identification of these firms employed the principles of the Delphi technique to select a panel of experts who are knowledgeable of the area to be surveyed.

### Characteristics of Respondents

A total of 27 persons participated on the panel by returning survey forms. These respondents represented 13 large firms of 500 or more employees and 14 firms with less than 500 employees. This panel of 27 experts represented the following position titles in their respective firms:

| POSITION TITLE | NUMBER OF RESPONDENTS |
|---|---|
| President | 7 |
| Senior Vice President | 1 |
| Vice President | 3 |
| General Manager | 1 |
| Director | 2 |
| Manager | 9 |
| Supervisor | 2 |
| Engineer | 2 |

The total number of employees in all firms represented in the sample was 18,981. This pool of employees equals 41 percent of the employees in all manufacturing firms located in the Toledo SMSA.

Eight of the respondents reported that their firm in the Toledo area was a headquarters for research and development. Nine reported that their firm was the headquarters for a multi-plant operation. Those respondents employed at a single-plant firm occurred in seven instances and at a multi-plant firm in eleven cases.

TABLE 4.5
COMPARISON WITH NATIONAL FORECAST OF HIGH TECHNOLOGY
IMPLEMENTATION IN LARGE, SMALL AND TOTAL SAMPLE OF FIRMS

| HIGH TECH USE AREAS | #1 FORECAST OF NAT'L GROWTH | #2 LARGE RESPONSES | #3 SMALL RESPONSES | #4 TOTAL RESPONSES |
|---|---|---|---|---|
| Computer-aided design (CAD) | 27% | 23% | 24% | 24% |
| Group Technology (GT) | 12 | 16 | 14 | 15 |
| Manufacturing Planning and Control Systems (MPCS) | 10 | 13 | 13 | 13 |
| Automated Materials Handling (AMH) | 7 | 9 | 10 | 9 |
| Computer-aided Manufacturing (CAM) | 10 | 14 | 17 | 15 |
| Robotics | 28 | 26 | 25 | 25 |
| Computing Technology (CT) | 17 | 19 | 20 | 20 |

Only in the case of CAM were the large and small firms significantly different. There is a three percentage point spread in this category. The category with the least expected annual growth predicted by both the national projections and responses of local firms was Automated Materials Handling (AMH). The largest percentage spread between the local responses and the national predictions was in the CAM high tech use area with a five percentage difference. The projected percentage was 10 percent as compared to the survey response of 15 percent.

One of the goals of the survey was to obtain an indicator of the prevalence of high technology equipment presently in operation in local plants. The respondent was asked to make a simple "yes" or "no" response for each of the seven high tech use areas to the question "Do you presently utilize high technology in your Northwest Ohio facility?" The results, again by "large," "small," and "total" compilations, are shown in Table 4.6.

TABLE 4.6
PERCENTAGE OF SURVEYED FIRMS UTILIZING
HIGH TECHNOLOGY EQUIPMENT

| HIGH TECH | LARGE | | SMALL | | TOTAL | |
|---|---|---|---|---|---|---|
| USE AREA | YES | NO | YES | NO | YES | NO |
| CAD | 63% | 27% | 43% | 57% | 48% | 52% |
| GT | 27 | 73 | 15 | 85 | 21 | 79 |
| MPCS | 91 | 9 | 53 | 47 | 69 | 31 |
| AMH | 64 | 36 | 14 | 86 | 36 | 64 |
| CAM | 55 | 45 | 33 | 67 | 42 | 58 |
| ROBOTICS | 45 | 55 | 14 | 86 | 28 | 72 |
| CT | 81 | 19 | 66 | 34 | 73 | 27 |

This table shows a significantly higher level of current implementation of high technology in the larger firms as compared to the smaller firms. Similar results were demonstrated earlier in the responses made to the question concerning comparability to national projections by 1987 and when the non-respondents to the survey were personally contacted. The non-responding firms tended to be smaller firms of fewer than 160 employees, and they indicated they were not involved in high technology.

There were only two high tech use areas where less than half of the "large" firms had not implemented high technology. These were Group Technology (27%) and Robotics (45%). Conversely, only in two areas had over half of the small firms implemented high technology. These were Manufacturing Planning and Control Systems (53%) and Computing Technology (66%); however, in both cases, again, the proportion of "small" firms was less than those of the "large" firms.

Another goal of the survey was to gather predictions by the panelists on the relationship of their own facilities' implementation of high technology equipment to the forecast of the national average of annual percentage growth through 1987. Table 4.7 reports this data.

TABLE 4.7
A PERCENTAGE COMPARISON BY "HIGH TECH USE AREA" OF SURVEYED FIRMS
TO NATIONAL PROJECTIONS OF IMPLEMENTING HIGH TECHNOLOGY

| | -------LARGE------- | | | -------SMALL------- | | | -------TOTAL------- | | |
|---|---|---|---|---|---|---|---|---|---|
| USE AREA | ABOVE | EQUAL | BELOW | ABOVE | EQUAL | BELOW | ABOVE | EQUAL | BELOW |
| CAD | 40 | 30 | 30 | 8 | 46 | 46 | 22 | 39 | 39 |
| GT | 64 | 36 | 0 | 0 | 9 | 91 | 32 | 23 | 49 |
| MPCS | 55 | 36 | 9 | 29 | 29 | 43 | 40 | 32 | 38 |
| AMH | 18 | 45 | 36 | 0 | 46 | 54 | 8 | 46 | 46 |
| CAM | 54 | 27 | 18 | 21 | 43 | 36 | 36 | 36 | 28 |
| ROBOTICS | 36 | 36 | 27 | 0 | 31 | 69 | 17 | 33 | 50 |
| CT | 73 | 27 | 0 | 29 | 29 | 43 | 48 | 28 | 24 |

The comparison of the "large" and "small" firms in this table is similar to the tables described above in the sense that the "large" group anticipates a greater level of automation in the future. For the overall total group of firms, only in Robotics does the expected level of implementation by as many as half of the firms fall below the national average. On the other hand, Manufacturing Planning and Control System, CAM and Computing Technology results show that over 70 percent of all the firms reporting believe they will be equal to or above the average national percentage growth in these three high tech use areas.

Manpower Requirements

One of the principle concerns of this project was to identify the support systems that are required for high tech manufacturing processes. After ascertaining the level of those systems currently available in the community, the task becomes that of determining what steps should be implemented to develop the required support level to encourage and foster high tech implementation in the manufacturing sector of the Toledo economy. A key support requirement of high technology is available manpower. Consequently, the survey addressed this concern by asking the respondent to evaluate the level of difficulty in finding skilled manpower

on a three-point scale: 1 = severe difficulty, 2 = moderate difficulty, and 3 = minimal difficulty.

The seven high tech use areas identified earlier were employed in a matrix with seven levels of skills required for high technology equipment employed in the manufacturing process. These skill levels have similar training, experience background, and operational requirements that are comparable across all of the high tech use areas. The results of the data are presented in Table 4.8. The first number in the column for each "high tech use area" is a mean of all responses on the scale of 1 to 3 (severe difficulty to minimal difficulty). The second number is the average deviation. The purpose of the average deviation is to show the spread of responses clustered around the mean. The third number is the mode, that is the number on the scale of 1, 2, or 3 that was selected in the greatest number of cases. The respondent gave not only the present manpower requirements, but projected the level of difficulty in obtaining skilled manpower for the next five years as well. (See Table 4.8)

The final figures at the bottom of each column are the averages of all responses in the respective column. Each is noted as an average of the present or five-year projection. By rank ordering these averages, the type of skilled manpower from most to least difficulty by type of skill can be identified. These rank orderings are as follows:

| PRESENT | FIVE YEARS |
|---|---|
| Design Capabilities | Design Capabilities |
| Programming Skills | Troubleshooting & Repair |
| Troubleshooting & Repair | Managerial |
| Skilled Trades | Programming Skills |
| Systems Operator | Skilled Trades |
| Managerial | Systems Operator |
| Equipment Operator | Equipment Operator |

The mean relationships of the seven skill levels in computer-aided deisgn application of high technology is shown by the present (shaded) bars in the bar graph illustrated in Figure 4.1.

TABLE 4.8

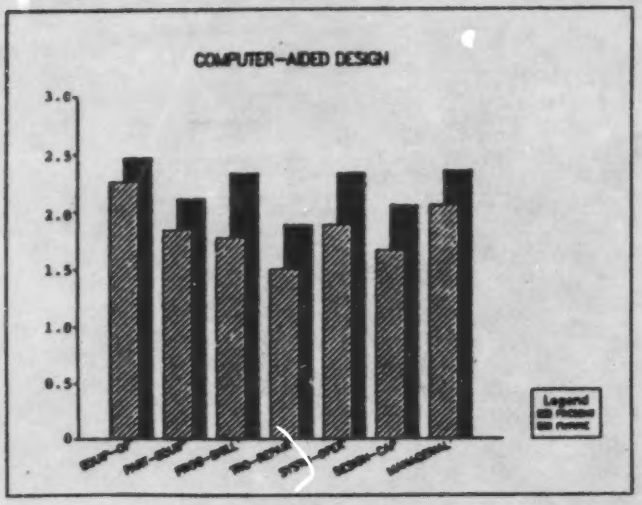
LEVEL OF DIFFICULTY IN MANPOWER RECRUITMENT

| HIGH TECH USE AREAS | EQUIPMENT OPERATOR | | SKILLED TRADES | | PROGRAMMING SKILLS | | TROUBLE-SHOOTING AND REPAIR | | SYSTEMS OPERATOR | | DESIGN CAPABILITIES | | MANAGERIAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PRSNT | 5 YRS | PRSNT | 5 YRS | PRSNT | 5 YRS | PRSNT | 5 YRS | PRSNT | 5 YRS | PRSNT | 5 YRS | PRSNT | 5 YRS |
| CAD | ǂ2.26 | 2.47 | 1.84 | 2.11 | 1.77 | 2.33 | 1.50 | 1.88 | 1.88 | 2.33 | 1.66 | 2.05 | 2.05 | 2.35 |
| | ǂǂ .46 | .55 | .47 | .59 | .60 | .51 | .55 | .39 | .49 | .66 | .51 | .41 | .38 | .52 |
| | ǂǂǂ 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| GT | 2.31 | 2.56 | 2.06 | 2.26 | 1.80 | 2.33 | 2.00 | 2.06 | 2.00 | 2.50 | 1.62 | 1.93 | 1.93 | 2.20 |
| | .68 | .49 | .62 | .39 | .53 | .53 | .53 | .37 | .50 | .56 | .54 | .35 | .49 | .64 |
| | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | (2,3) |
| MPCS | 2.47 | 2.71 | 2.23 | 2.33 | 1.85 | 2.33 | 2.00 | 2.14 | 2.23 | 2.47 | 1.80 | 2.19 | 2.14 | 2.33 |
| | .49 | .40 | .61 | .61 | .65 | .50 | .57 | .40 | .43 | .54 | .53 | .46 | .48 | .56 |
| | 2 | 3 | 3 | 3 | (1,2) | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| AMH | 2.73 | 2.84 | 2.31 | 2.52 | 2.05 | 2.42 | 2.15 | 2.31 | 2.21 | 2.42 | 1.84 | 2.15 | 2.00 | 2.21 |
| | .38 | .26 | .57 | .49 | .49 | .54 | .53 | .50 | .41 | .54 | .44 | .35 | .31 | .49 |
| | 3 | 3 | 2 | 3 | 2 | (2,3) | 2 | 2 | 2 | (2,3) | 2 | 2 | 2 | 2 |
| CAM | 1.85 | 2.30 | 1.80 | 2.25 | 1.57 | 2.10 | 1.80 | 2.00 | 1.78 | 2.10 | 1.31 | 1.78 | 1.73 | 1.89 |
| | .46 | .46 | .51 | .45 | .59 | .27 | .64 | .40 | .58 | .65 | .46 | .65 | .62 | .56 |
| | 2 | 2 | 2 | 2 | 1 | 2 | (1,2) | 2 | 2 | (2,3) | 1 | 1 | (1,2) | 2 |
| ROBOTICS | 1.98 | 2.44 | 1.55 | 2.22 | 1.55 | 2.11 | 1.66 | 2.11 | 1.58 | 2.29 | 1.16 | 1.61 | 1.75 | 2.16 |
| | .59 | .49 | .61 | .51 | .62 | .39 | .66 | .59 | .48 | .41 | .27 | .47 | .62 | .41 |
| | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 |
| CT | 1.95 | 2.40 | 1.80 | 2.20 | 1.75 | 2.10 | 1.80 | 2.20 | 1.90 | 2.35 | 1.45 | 1.70 | 1.95 | 2.15 |
| | .61 | .55 | .54 | .38 | .60 | .54 | .55 | .52 | .35 | .58 | .54 | .63 | .47 | .51 |
| | (1,2) | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | (2,3) | 1 | 1 | 2 | 2 |
| GRAND AVE. | 2.21 | 2.53 | 1.94 | 2.27 | 1.76 | 2.25 | 1.84 | 2.10 | 1.94 | 2.35 | 1.55 | 1.92 | 1.94 | 2.18 |

NOTE: 1 = Severe Difficulty 2=Moderate Difficulty 3=Minimal Difficulty

ǂ = Mean ǂǂ = Average Deviation ǂǂǂ = Mode

FIGURE 4.1




The five-year projected level of recruiting difficulty is shown by the adjoining future (black) bars. The more severe the manpower shortage is, the closer the bar will be to the one on the scale (bottom of the graph) than to the three (top of the graph). Graphs for each of the other six high tech use areas are displayed on the following pages.

The priority of type of skilled manpower, based upon the level of severe recruiting difficulty at the present time and in five years, is shown below in Table 4.9:

TABLE 4.9
MANPOWER SHORTAGE

| SKILL LEVEL | HIGH TECH USE AREA | PRESENT SHORTAGE | FIVE-YEAR PROJECTED SHORTAGE |
|---|---|---|---|
| Equipment Operator | Computer Tech | X | |
| Skilled Trades | Robotics | X | |
| Programming Skills | MPCS | X | |
| | CAM | X | |
| | Robotics | X | |
| Troubleshooting | CAD | X | |
| | Robotics | X | |
| Design Capabilities | CAM | X | X |
| | Robotics | X | |
| | Computer Tech | X | X |
| Manager | CAM | X | |
| | Robotics | X | |

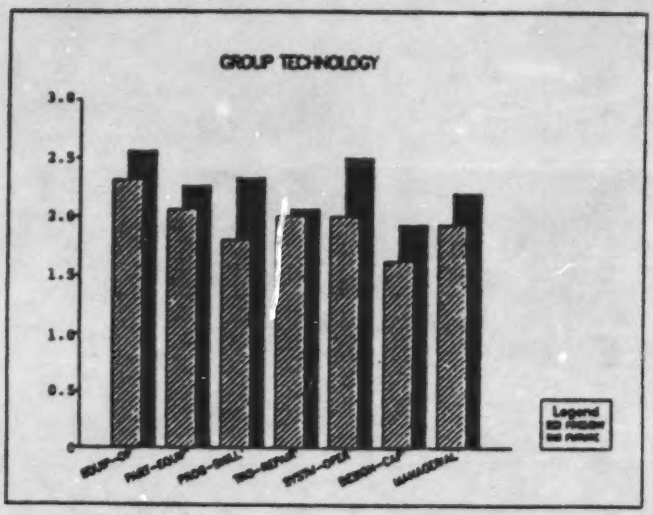



FIGURE 4.2

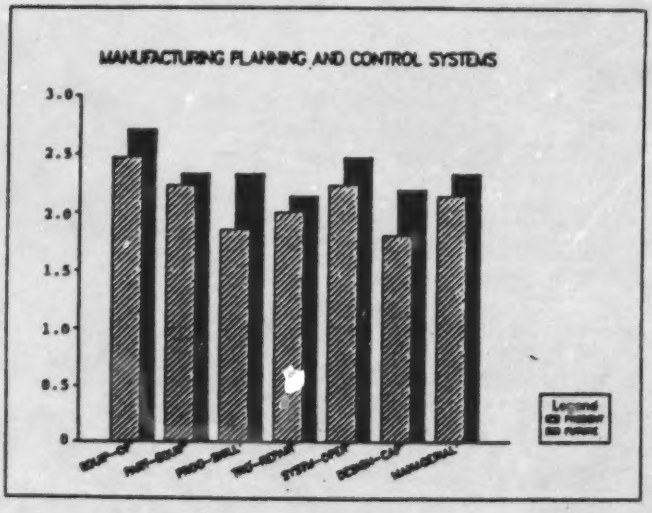



FIGURE 4.3

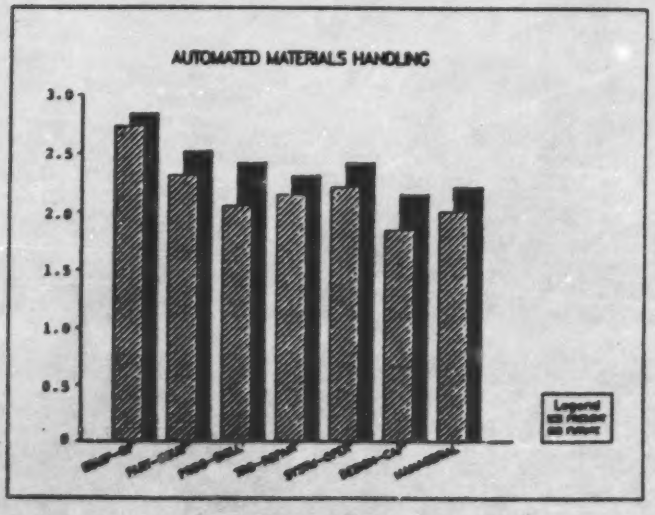



FIGURE 4.4

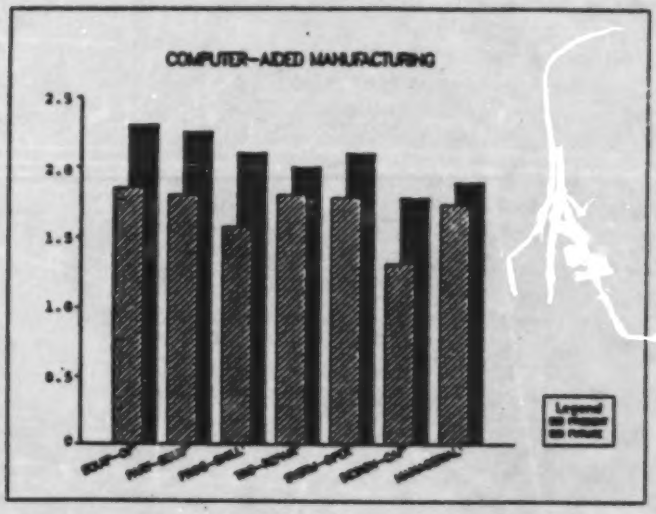



FIGURE 4.5

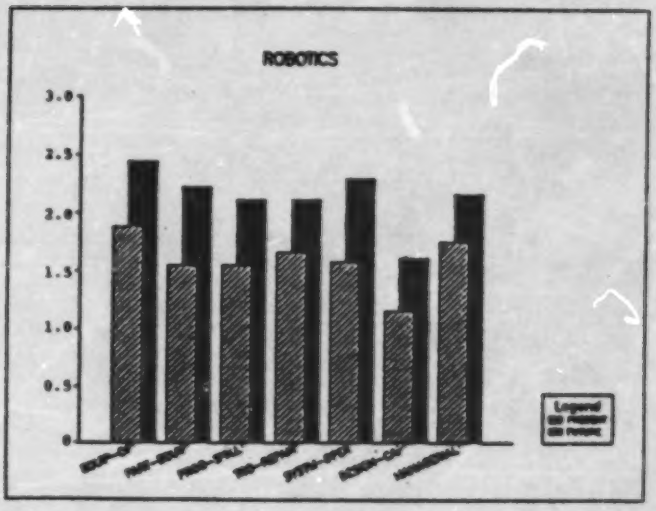



FIGURE 4.6

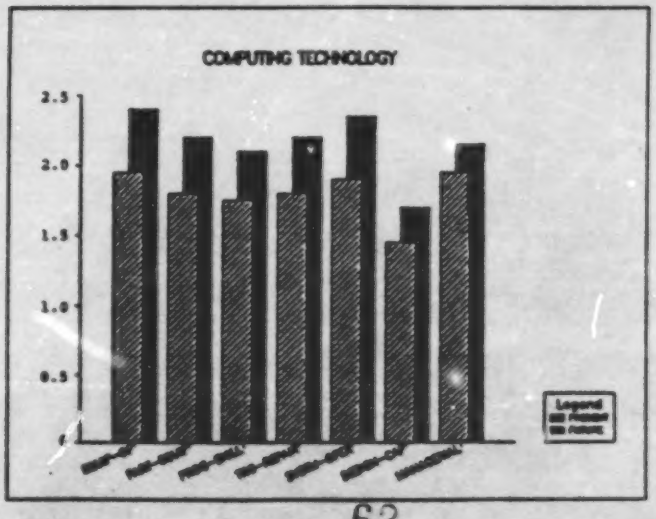



FIGURE 4.7

The large and small firms were compared on the question in the survey which asked for the sources of trained personnel needed over the next five years. The first priority for the "small" group was to retrain existing personnel with in-house training while the "large" group expects to hire college graduates from within a fifty-mile radius of Toledo. The first priority for the "small" group was the fifth priority for the "large" group. Both saw other manufacturers in the Toledo area as the second principle source for meeting manpower requirements. Table 4.10 shows the results of each group's response to the question on the source of personnel.

TABLE 4.10
RANK ORDER OF SOURCES OF TRAINED
PERSONNEL NEEDED OVER NEXT FIVE YEARS

| SMALL FIRMS | LARGE FIRMS | SOURCE OF PERSONNEL |
|---|---|---|
| 5 | 1 | Graduating college students of institutions located in 50-mile radius of Toledo |
| 6 | 4 | Graduating college students outside 50-mile radius of Toledo |
| 1 | 5 | Retraining existing personnel with in-house training |
| 3 | 6 | Retraining existing personnel in local institutions |
| 2 | 2 | Hiring personnel from manufacturers in Toledo area |
| 4 | 3 | Hiring personnel from manufacturers outside Toledo area |

Comparing the rank orderings showed that the larger firms placed greater reliance than the smaller firms on hiring trained personnel outside the Toledo area. The small firms do not rank this potential until the fourth and sixth priorty as compared to the third and fourth priority in the large firms.

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Another question from the survey concerned the placement of personnel who are displaced by automated equipment. The order of priority was:

1. Retrain for new position in present plant.
2. Transfer without training.
3. Retrain for new position in another plant.
4. Retire early.
5. Terminate.

Summary

The data reported in this chapter was gathered from manufacturing firms in the Toledo area who proportionately represented the total population based upon their classification by product output. The respondents also represented a large percentage of all manufacturing employees in the area. Unfortunately, the size of firms represented by the respondents was weighted by large firms. As the survey demonstrated, however, this selectivity is a result of the relative experience and capability the larger firm has in implementing high tech equipment. This factor, itself, is cause for a concern on the viability of the smaller firms in the face of world-wide competition and will be addressed in Chapter 5.

# CHAPTER 5

## SUMMARY AND RECOMMENDATIONS

The rapidly deteriorating health of the manufacturing sector of the nation's economy and its widely-acclaimed cure of "high technology" have recently been thrust into the forefront of the consciousness of this nation. The President visits a factory to marvel at the wonders of these two forces, Congress establishes a special office to study and recommend how to accommodate these new challenges, and Ohio's Governor proposes a special "high technology center" to help bring Ohio into the new technological world. Whether the Toledo Technical Society sponsors a conference on "Robotics and Smart Automation," NBC-TV produces a white paper on the automated factory, or a CETA prime sponsor funds a study on high technology, there is ample certainty that the problems of the manufacturing sector and the potential help from high technology are two subjects that will not soon disappear from this nation's agenda.

World-wide dislocations of the economic structures, such as the Arab oil boycott with its attendant end of cheap energy and the growth and development of the Third World Nations, have helped to foster our current dilemma. Relief from the current recession through an improvement in the economic indicators may provide welcomed news; however, in the midst of that positive note, we cannot afford to allow ourselves to be lulled into complacency about the challenge our nation faces regarding the peril of the manufacturing base. The substance of Chapter 2, "A Review of the Literature on the Manufacturing Sector," amply describes the depth of the threat to our workforce and our nation's viability in the new world economy.

The Toledo area economy is a bellweather for some of the larger challenges the nation faces in its manufacturing health. Toledo's per capita income proportion slipped from 105.2 to 99.8 percent of the U.S. average in just one decade, the unemployed grew from 17,400 to 39,680, and the percentage of manufacturing jobs decreased by 17.2 percent. The conventional wisdom of most commentators evaluating the current manufacturing scene today is that many of the current 13 percent unemployed in the Toledo area will never again return to the factory floor. The future prognosis suggests that the current layoffs will not be the last but that the processes underway will continue, and today's ranks of unemployed will continue to increase given normal extrapolation of the current trends.

In the course of this project, a survey question asked respondents to estimate the average annual increase in the implementation of high technology equipment. Seven use areas were identified, and in only two use areas, CAD and Robotics, were the estimates below the national average projection. Nevertheless, it is sobering to note that these two use areas account for 55 percent of all high technology equipment forecast to be implemented in the next five years. This means that in over half of the expected applications of high technology, the Toledo industry will be below the national average.

The intent of this paper is not to sound the death knell of Toledo's manufacturing industry; but to the contrary, it is to call for action and to set an agenda to instill new life in an aging economy by developing a support base for local industry to automate and retrain its workforce to attain full employment.

RECOMMENDATION #1--ECONOMIC DEVELOPMENT IN TOLEDO MUST CONCENTRATE ON HIGH TECHNOLOGY APPLICATION RATHER THAN DEVELOPMENT OF HIGH TECHNOLOGY INDUSTRY. The deliberations of the High Technology Task Force led it to recommend minimizing efforts to encourage research and development and/or production of high tech equipment and products. Rather, the Task Force elected to favor maximizing efforts to encourage the implementation of high technology equipment in the manufacturing base that already exists in the Toledo industry.

A recent study released by the Joint Economic Committee of Congress was an analysis of factors that are considered by high technology firms when they relocate or expand. A positive note of the study for the Midwest is that expansion by high tech firms in the 1980s will tend to favor the Upper Midwest. On the negative side, however, for many communities in the Midwest is the fact that among the most important ingredients sought in a locale by a high tech firm is a major research and educational climate competitive with MIT and Stanford University.

The results of this congressional study, coupled with the proliferation of efforts to recruit high tech firms in almost every state and in multiple regions and local communities across the nation, led the High Technology Task Force to discourage employing local resources to attempt to alter the economic base by shifting to a high tech industry base. There were two observations by the Task Force which had a pervasive influence on its recommendation that efforts be directed toward assisting firms in the manufacturing process of durable goods to implement high technology equipment. One influence was the Wall Street Journal article by Gurwitz, quoted in Chapter 2, which questions the movement by many

communities to recruit high technology as an expensive and frivolous fad. The second influence was the unfulfilled hopes of a carefully designed recruitment program for electronic and instrument measurement companies by a sister city--Dayton, Ohio.

RECOMMENDATION #2--A SURVEY OF HIGH TECHNOLOGY ACTIVITY IN THE NON-MANUFACTURING SECTORS OF THE LOCAL ECONOMY MUST BE ACCOMPLISHED. In view of the resources available to accomplish this project, a decision was made by the Task Force as it initially reviewed its assignment that the universe of "high technology" must be broken into manageable components. High technology has made significant inroads into industries other than manufacturing, such as banking and finance, health, and communications. Because the role of the manufacture of durable goods holds such importance to the local Toledo economy, however, a conscious decision was made by the Task Force to delimit its inquiry to this sector of the Toledo economy. The assumption was made that there was sufficient commonality of employment of high technology in various sectors of the economy that the criteria and instruments developed in this study could later be adapted to investigate these other applications of high technology to the economy. Therefore, a second recommendation is that a base of data and information be accumulated in these fields as well as the manufacturing sector.

RECOMMENDATION #3--LOCAL INDUSTRY SHOULD BE SENSITIZED TO THE BENEFITS AND APPLICATIONS OF HIGH TECHNOLOGY. In reviewing the data from the survey, the level of implementation of high tech equipment in the larger, as compared to the smaller, firm becomes obvious. In fact, the Task Force had a prescience of the results of the data when the members contacted the non-respondents in a follow-up.

Predominantly, these firms contacted were small firms who saw high technology of minimal interest to them in their role as a manufacturer. Many viewed the capital-intensive new processes as beyond the resources of their individual firms. In reality, however, the questionnaire incorporated high technology equipment, such as programmable controllers, which most plants already have in place. However, the perception by those contacted in many instances was the lack of expertise in a field which was of scant use to the firm.

A third recommendation of the Task Force is, therefore, the need to raise the consciousness of the leaders of the local industry on the applications and benefits of high technology to specific manufacturing processes. The Conference on Robotics and Smart Automation sponsored by the Toledo Technical Society in recognition of National Engineering Week 1983 was an important beginning and illustration of this recommendation. Symposiums, conferences, workshops, seminars and other formats need to be developed and marketed specifically for the local industrialist to assure that those who have the responsibility for determining the future directions of our industries will have the latest and most accurate information.

Additionally, the fluidity and rapid changes occuring in this field require availability of the latest information for the larger firms as well. Large firms may have greater capability than small firms to have experts in the application of high technology on its staff, but to ensure that these industries are supported as well, the special training offerings can provide a vital service to both the large and small firms.

RECOMMENDATION #4--THERE MUST BE STRATEGIC PLANNING FOR SKILLED MANPOWER. One of the unmistakable lessons the Task Force

learned from its review of the literature was the crucial role of a trained, skilled workforce in a progressive, growing high technology environment. This requirement was the highest priority that emerged in the Joint Economic Committee's national survey of firms that was designed to determine the ranking of factors which are employed in a management determination of where to establish or relocate plants. Independent studies completed in Binghamton, New York, and in Michigan reiterated this concern for skilled manpower.

As a consequence, the Task Force incoporated within its survey a unique approach to identify potential shortages of manpower. The intent was to develop strength in the manpower resources for the community in order to support its present industry as well as to recruit new industry to come to the area because of adequate manpower resources.

The fourth recommendation of the Task Force is that those areas of skill recruitment identified as "moderate" to "severe" difficulty be proposed to the local educational institutions for appropriate training and upgrading of the current and future workforce.

The survey identified seven levels of clusters of job skills. Each cluster has common basic skills and knowledge requirements in each of the identified seven high tech use areas. In reviewing the data, the Task Force considered a skill to be in short supply if the mean plus the average deviation was less than 2.75 on a 3-point scale with 1 = severe difficulty, 2 = moderate difficulty, and 3 = minimal difficulty.

The results of the data show the following shortage of skills in the next five years:

1. Equipment Operators in CAM.
2. Skilled trades in CAD, Group Technology, CAM, Robotics and Computing Technology.

3. Programming skills in CAD, Robotics and Computing Technology.
4. Troubleshooting and repair skills in CAD, Group Technology, MPCS, CAM, Robotics, and Computing Technology.
5. Systems Operator in Robotics.
6. Design capabilities in all seven high tech areas.
7. Managerial skills in CAM, Robotics and Computing Technology.

RECOMMENDATION #5--A COORDINATING CENTER FOR HIGH TECHNOLOGY ACTIVITIES SHOULD BE DEVELOPED IN THE TOLEDO AREA. Although the Task Force reviewed many models of studies that were in process or had been completed on communities across the country, none of them had made a systematic attempt to predict the expected growth of high technology or the availability of one of the most important ingredients for success, skilled manpower. The Task Force believes this study provides an important base of information on which to build future programming and agendas and that this base is often lacking in other models reviewed.

The implementation of these recommendations probably will not happen on their own, however. They require direction and coordination. Additionally, many other facets of assistance were not incorporated in this study which need further attention; i.e., tax reform, capital resources, technical and small business assistance, etc.

A final recommendation, therefore, by the Task Force is to establish a coordinating center for all activities related to high technology. The state-level "High Technology Center" recently proposed by a state-wide task force appointed by the Governor may provide some guidelines on the role and structure of such a center for the Toledo area. Conceivably, this center could provide a focus to coordinate a widely diverse range of developmental activities in high technology in the community.

RECOMMENDATION #6--ACTION SHOULD BE TAKEN ON THE IMPLEMENTATION OF THESE RECOMMENDATIONS BY THE PRIVATE INDUSTRY COUNCIL. The Task Force wants to assure the continuity of progress in efforts to meet the reindustrialization needs of the local industry. It recommends and encourages, therefore, that the Private Industry Council apppoint an Implementation Committee or take other actions it deems advisable toward initiating the recommendations of this report. The Task Force believes its findings are pertinent to reindustrialization issues, and it is confident that these recommendations will have a positive influence in the community.

Conclusion

This report is submitted to the Private Industry Council and other community planning groups to assist in clarifying current issues the community faces and to plan intelligently for the future. The recommendations submitted are without any structural or organizational framework. This approach was selected in the hope that each recommendation can be discussed and debated minus the trappings of allegiances or self-interests and that, after a consensus is reached on the relative importance and viability of the recommendations, who will do what, and when, and where it will be done can be to the advantage of the community as a whole.

# APPENDIX I

## QUESTIONNAIRE

CALLER #10,000 • OREGON ROAD, TOLEDO, OHIO 43699 • PHONE: 419/666-0580

OWENS TECHNICAL COLLEGE

PREPARING PEOPLE FOR MORE THAN 40 TECHNICAL CAREERS.
SPECIALIZING IN MANPOWER TRAINING SINCE 1966.

December 9, 1982

Dear

You recently received a letter from the Chamber of Commerce announcing a high technology study and a survey to provide necessary data. The results of this project are intended to assist the planning councils of the Toledo area in identifying steps that can be initiated to support and assist our local manufacturing firms as they implement high tech equipment. A task force representing local industry and related agencies has been investigating these concerns for several months. The enclosed survey instrument has been carefully designed to assist in developing a number of recommended steps that can be initiated to foster the implementation of high tech equipment. The goal is to realize greater productivity and to provide an environment conducive to manufacturing growth for Toledo.

After considerable deliberation, the task force has adopted the "Delphi Technique" as the best method to provide the data needed. An advantage of this research avenue is that no data-gathering is required by the respondent. Rather, we request the informed judgment of "experts" in the field whom we refer to as "panelists." This particular technique has been employed extensively by the Society of Manufacturing Engineers.

After the data from the enclosed questionnaire is analyzed, a second round of the same questions will be returned to the panelists showing the collective opinion of all respondents. Each panelist will be asked to respond again in view of the estimates of his/her peers. This method develops a consensus, or "best estimate," of those knowledgeable in the field.

Our request is that the enclosed survey be completed by a staff member you consider knowledgeable about the application of high technology to your firm's manufacturing processes. We have attached a return postcard to this letter and ask that you complete it with the name and phone number of the person whom

you select to be the panelist. Please note a code is shown on the card, since the questionnaire data will be segregated from the respondent's name to assure anonymity in the evaluation of the data. If we have not received the attached card by December 17, we will contact you.

Finally, we recognize that this survey adds to your task of responding to many requests for information. We hope the brevity of the form minimizes the effort required. This survey, which is funded by the Private Industry Council (PIC), is complementary to the Labor Market Survey also sponsored by the PIC.

You are encouraged to call me at 666-0580 if you have questions or need further clarification concerning the questionnaire or the project in general.

Sincerely,

Ivan G. Kurtz, Ph.D.
Director, High Tech Survey Project
and
Provost, Owens Technical College

Enclosures

CALLER #10,000 • OREGON ROAD, TOLEDO, OHIO 43699 • PHONE: 419/666-0580

OWENS TECHNICAL COLLEGE

PREPARING PEOPLE FOR MORE THAN 40 TECHNICAL CAREERS.
SPECIALIZING IN MANPOWER TRAINING SINCE 1966.

Dear Panelist:

The day of automated-manufacturing processes is upon us. Manufacturing firms are grappling with issues related to automation that apply to their respective situations. Experiences around the country show that a key ingredient in a successful move into high technology by an employer is influenced by the level of support services available locally, such as trained, skilled manpower. This research project, funded by the Private Industry Council (PIC), intends to identify the level of growth through 1987 in applying high technology to the Toledo area's manufacturing firms. The data will then be used to formulate recommended actions needed by planning agencies to develop and have in place the necessary support systems the area's manufacturing sector will require as it elects to improve productivity

This survey is being made in cooperation with the Toledo Area Chamber of Commerce and complements the public relations plans of the "Toledo Alive" program of the Chamber. Mr. J. Michael Porter, Chamber President, has communicated with the Chief Executive Officer of each firm selected in a random sample to encourage cooperation in this project by assigning responsibility to someone within the firm to complete the questionnaire.

Your firm was one of 75 selected in a random sample of all firms in Lucas (including the city of Toledo), Wood, and Ottawa Counties who manufacture products in the six standard industry classifications (SIC) of glass, primary metal, fabricating, machining, electrical, and transportation. The use of "Northwest Ohio" throughout the survey is defined to apply to facilities located in these three counties.

The survey method we are using, the "Delphi Technique," is one employed extensively by the Society of Manufacturing Engineers and the University of Michigan to predict or forecast future developments in high technology. You are asked to be one of the respondents, or "panelists," representing the 75 firms in our sample. After evaluating all returns, a follow-up questionnaire will be sent to you giving the panelists' "average" response and soliciting your agreement or disagreement with the group's average response. This method is an excellent one to develop a consensus of "experts" in the field.

We encourage you to respond to the questions on the survey with you best-educated estimate. Also, we welcome your comments on the items in the questionnaire. Your comments will be incorporated in the follow-up questionnaire. The data from this survey will be kept strictly confidential. A code has been assigned to each panelist and maintained separate from the completed survey forms.

This survey culminates a long, preparatory effort on the part of a High Technology Task Force composed of representation from six corporations, the Chamber of Commerce, two institutions of higher education, a union officer, and a real estate developer. The work on this task force began several months ago, and we look forward to publishing our recommendations in the near future. You will, of course, receive a copy.

If you have any particular problems or questions in completing this survey, please feel free to call Dr. Ivan Kurtz at 666-0580. As mentioned previously, you are one of a random sample. Your assistance is crucial to the usefulness of our data.

Sincerely,

Ivan G. Kurtz, Ph.D.
Director, High Tech Survey Project
and
Provost, Owens Technical College

Enclosure

HIGH TECHNOLOGY SURVEY CODE: _____

Rank order the following sources of trained personnel needed over the next five years to meet your manpower requirements for high technology equipment.

____ Graduating college students of institutions located in Ohio and Michigan *within a 50-mile radius* of Toledo
____ Graduating college students *outside the 50-mile radius* of Toledo
____ Retraining existing manufacturing personnel with *in-house* training
____ Retraining existing manufacturing personnel *in local institutions*
____ Hiring experienced personnel from manufacturers *within* the Toledo area
____ Hiring experienced personnel from manufacturers *outside* the Toledo area
____ Other--Please specify: _____

COMMENTS: _____

Rank order your forecast on replacement over the next five years of professional-trained personnel displaced by automated equipment, i.e. personnel with a minimum of four-year degree and experience in the profession.

____ Transferred without retraining
____ Retrained for a new position in present plant
____ Retrained for a new position in another plant
____ Terminated
____ Retired early
____ Other--Please specify: _____

COMMENTS: _____

Rank order your forecast on replacement over the next five years of technical-trained personnel displaced by automated equipment, i.e. personnel who completed technical training (two-year associate degree or equivalent) and who are career oriented to the technician level.

____ Transferred without retraining
____ Retrained for a new position in present plant
____ Retrained for a new position in another plant
____ Terminated
____ Retired early
____ Other--Please specify: _____

COMMENTS: _____

How would you describe your plant facility?

____ Headquarters for research and development or engineering
____ Headquarters for a multiplant operation
____ Single-plant firm
____ Multi-plant firm

COMMENTS: _____

Listed in Column 1 below are seven different applications of high technology to the manufacturing process. These applications are called "High Technology Use Areas." Column 2 gives a national projection of the annual percentage growth expected through 1987 of high technology in each use area. In Column 3 indicate your forecast regarding the percentage of annual growth through 1987 of each high technology use area in the manufacturing process in firms in Northwest Ohio. Check (✓) "yes" or "no" in Column 4 if your manufacturing facility(ies) located in Northwest Ohio presently uses high technology as described in any of the seven use areas. Place a check (✓) in Column 5 to indicate your firm's level of growth compared to the national percentage forecast shown in Column 2.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| HIGH TECHNOLOGY USE AREAS | FORECAST OF NATIONAL AVERAGE ANNUAL PERCENTAGE GROWTH THROUGH 1987 | YOUR PERCENTAGE FORECAST OF NW OHIO INDUSTRY AVERAGE ANNUAL GROWTH THROUGH 1987 | DO YOU "PRESENTLY" UTILIZE HIGH TECH IN YOUR NW OHIO FACILITIES (YES OR NO) | LEVEL OF HIGH TECH UTILIZED "BY 1987" IN YOUR NW OHIO FACILITIES AS COMPARED TO COLUMN 2 (NATIONAL) |
| COMPUTER-AIDED DESIGN (CAD)--Includes four major functions: computer-aided design itself; computer-aided engineering (CAE), which includes all of the analytical software used to analyze part designs; computer-aided process planning; and numerically controlled (NC) part programming. | 27% | | ___ YES<br>___ NO | ___ ABOVE<br>___ EQUAL TO<br>___ BELOW |
| GROUP TECHNOLOGY (GT)--Comprises parts-related classification and coding, along with the process-related function of grouping machines into manufacturing cells to produce families of parts. | 12% | | ___ YES<br>___ NO | ___ ABOVE<br>___ EQUAL TO<br>___ BELOW |
| MANUFACTURING PLANNING AND CONTROL SYSTEMS (MP & CS)--Encompasses manufacturing resource planning (MRP), distribution resource planning (DRP), standard cost reporting, simulation and/or optimization software, shop floor data collection, decision support software, manufacturing management graphics, preventive maintenance software, and other similar types of software. | 10% | | ___ YES<br>___ NO | ___ ABOVE<br>___ EQUAL TO<br>___ BELOW |
| AUTOMATED MATERIALS HANDLING (AMH)--Includes traditional materials handling equipment such as pallet racks, conveyors and storage bins and automatic storage retrieval systems (AS/RS) and automatic guided vehicle systems (AGVS). | 7% | | ___ YES<br>___ NO | ___ ABOVE<br>___ EQUAL TO<br>___ BELOW |
| COMPUTER-AIDED MANUFACTURING (CAM)--Covers at least five major functions: Numerically controlled machine tools, flexible manufacturing systems (FMS); process control devices such as programmable controllers and microprocessors; automated assembly; & computer-aided inspection. | 10% | | ___ YES<br>___ NO | ___ ABOVE<br>___ EQUAL TO<br>___ BELOW |
| ROBOTICS--Stand-alone robots reflect an industry in its early stages of development. The future robotics industry will place increasing importance on linking and controlling multiple robots by computer software. | 28% | | ___ YES<br>___ NO | ___ ABOVE<br>___ EQUAL TO<br>___ BELOW |
| COMPUTING TECHNOLOGY--Is the integrater of the major manufacturing functions. Included are hardware, software, data base, and telecommunications. | 17% | | ___ YES<br>___ NO | ___ ABOVE<br>___ EQUAL TO<br>___ BELOW |

COMMENTS:

Listed below in the left-hand column are seven high technology use areas in the manufacturing process. Columns 1 through 7 identify skill levels from low to high (equipment operator (1) to managerial (7)) necessary for the employment of high technology in the manufacturing process. Each column asks for two responses regarding your evaluation of the difficulty in finding skilled manpower as presently required and as you anticipate it will be required in five years in view of any implementation of additional high technology equipment in your manufacturing process. Make your responses of skills required as either 1, 2, or 3 (1 = severe difficulty; 2 = moderate difficulty; 3 = minimal difficulty).

| HIGH TECHNOLOGY USE AREAS / SKILL LEVELS | EQUIPMENT OPERATOR | | SKILLED TRADES WITH SPECIFIC SKILLS ON PARTICULAR EQUIPMENT (e.g. VENDOR TRAINING) | | PROGRAMMING SKILLS | | TROUBLE-SHOOTING AND REPAIR SKILLS | | SYSTEMS OPERATOR | | DESIGN CAPABILITIES | | MANAGERIAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PRESENT | 5 YRS | PRESENT | 5 YRS | PRESENT | 5 YRS | PRESENT | 5 YRS | PRESENT | 5 YRS | PRESENT | 5 YRS | PRESENT | 5 YRS |
| COMPUTER-AIDED DESIGN (CAD)--Includes four major functions: computer-aided design itself; computer-aided engineering (CAE), which includes all of the analytical software used to analyze part designs; computer-aided process planning; and numerically controlled (NC) part programming. | | | | | | | | | | | | | | |
| GROUP TECHNOLOGY (GT)--Comprises parts-related classification and coding, along with the process-related function of grouping machines into manufacturing cells to produce families of parts. | | | | | | | | | | | | | | |
| MANUFACTURING PLANNING AND CONTROL SYSTEMS (MP & CS)--Encompasses manufacturing resources planning (MRP), distribution resource planning (DRP), standard cost reporting, simulation and/or optimization software, shop floor data collection, decision support software, manufacturing management graphics, preventive maintenance software, and other similar types of software. | | | | | | | | | | | | | | |
| AUTOMATED MATERIALS HANDLING (AMH)--Includes traditional materials handling equipment such as pallet racks, conveyors and storage bins and automatic storage retrieval systems (AR/RS) and automatic guided vehicle systems (AGVS). | | | | | | | | | | | | | | |
| COMPUTER-AIDED MANUFACTURING (CAM)--Covers at least five major functions: Numerically controlled machine tools, flexible manufacturing systems (FMS); process control devices such as programmable controllers and microprocessors; automated assembly; & computer-aided inspection. | | | | | | | | | | | | | | |
| ROBOTICS--Stand-alone robots reflect an industry in its early stages of development. The future robotics industry will place increasing importance on linking and controlling multiple robots by computer software. | | | | | | | | | | | | | | |
| COMPUTING TECHNOLOGY--Is the integrator of the major manufacturing functions. Included are hardware, software, data base, and telecommunications. | | | | | | | | | | | | | | |

COMMENTS: _____

# APPENDIX II

## LETTER OF INTRODUCTION FROM

## J. MICHAEL PORTER

## AND

## JACK HOYT

TOLEDO AREA CHAMBER OF COMMERCE

C-C

[illegible] HURON STREET TOLEDO, OHIO 43604 · PHONE (419) 243-[illegible]

November 24, 1982

XXX
XXX
XXX

Dear :

A survey is being conducted to identify the necessary support systems for high technology applications in our local industry. Experiences around the country clearly demonstrate that a key ingredient in a successful move into high technology by a firm is the availability of support systmes, such as trained, skilled labor. A task force on high technology, representative of six corporations, two institutions of higher education, the Chamber of Commerce, a union official, and a local real estate developer, has been working on this project for several months. I want you to know that staff members of the Chamber of Commerce have been working with this task force, and I have encouraged and supported their work. This survey project is funded and endorsed by the Private Industry Council for their use in planning long-range manpower development programs. Mr. Jack Hoyt, who is from Champion Spark Plug and is chairman of the Private Industry Council, is joining me in appealing for your efforts in responding to the questionnaire.

We certainly are hesitant to add to the proliferation of surveys and questionnaires you receive, but I have followed the progress of this particular study and see the usefulness of the data as complementing our "Toledo Alive" publicity project and data base. You will be receiving a questionnaire with an accompanying letter of explanation from Dr. Ivan Kurtz.

The method used in this survey is the Delphi Technique. This method requires no data gathering by your staff; rather some future projections, by a knowledgeable member of your management team, of high tech growth in your industry are solicited. This survey is being addressed to 60 manufacturing firms. Your cooperation will be helpful and appreciated.

Sincerely,

J. Michael Porter, President
Toledo Chamber of Commerce

Jack Hoyt, Chairman
Private Industry Council

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